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Storage of Nitrate Amateur Still-Camera Film Negatives*

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THE hazard involved in handling or storing any appreciable quantity of nitrate base photographic film has been recognized for a great many years. As a result, questions are frequently asked about the possible hazard in storing small quantities of the so-called "amateur" still-camera negatives on nitrate base. These were used in past years in a variety of roll film sizes such as 135, 616, 620, 828, etc. as well as in the form of film pack and sheet film. As far as the author knows, these types of film are no longer produced on nitrate support in the United States. However, many people have small collections of nitrate negatives of various ages up to 20 or 30 years, and a few even 40 to 50 years old. They are usually stored in desks or cupboards without any special precautions.

Small quantities of amateur nitrate negatives have never been considered hazardous but the chemical stability of cellulose nitrate is low. The degree of stability depends on the particular film, its history, and its storage conditions. For these reasons it is not possible to assure the photographer, either that decomposition or spontaneous combustion will never occur or, on the other hand, that all nitrate negatives are dangerous and should be copied and then destroyed. The truth lies somewhere between these two extremes.

* Received for publication February 25, 1953.

It is the purpose of this article to attempt to answer some of the questions that arise concerning the storage of small quantities of nitrate film negatives from both the hazard and preservation standpoint. Are these nitrate negatives likely to cause a fire? What quantity does constitute a hazard? Where and how should they be stored? What are the signs of incipient decomposition? What special precautions are necessary to preserve valuable nitrate negatives? Should they be copied on safety film? These questions are of interest, not only to amateur photographers, but also to those in science and industry who have small collections of nitrate still-camera negatives containing valuable records.

The storage of large quantities of nitrate films such as aerial film, motion picture film, or professional sheet film will not be considered here.

History of Nitrate Film

Cellulose nitrate containing over 13% nitrogen is known as guncotton and was first used in explosives about 1845[1]. Cellulose nitrate containing 10.5 to 12% nitrogen is called pyroxylin and has been used in plastics since about 1870. Pyroxylin is very flammable but is not explosive. Nitrate plastics, commonly known as "celluloid", are still used for many household articles such as foun-

tain pens, spectacle frames, drawing instruments, ping pong balls, brush handles, cases, buttons, and many others. These articles are flammable but are not considered hazardous in ordinary household quantities.

Cellulose nitrate made for film base contains about 12% nitrogen and, like celluloid, is very flammable but not explosive. It was first used for roll film in 1889 and for the first commercial motion picture film in 1895[2]. As the motion picture industry grew and quantities of nitrate film accumulated in film exchanges a number of serious film fires occurred. Following the Ferguson building film exchange fire in Pittsburgh in September 1909 the National Board of Fire Underwriters established rigid regulations governing the handling and storage of nitrate motion picture film. Similar regulations were established for the storage of nitrate X-ray and other nitrate photographic films about 1925. These regulations with some revisions are still in force today, implemented in many cases by state laws and local ordinances.

Another milestone in the history of nitrate film from the hazard standpoint was the Cleveland Clinic disaster which occurred in May 1929 as the result of the storage of large quantities of nitrate base X-ray film under unsafe conditions. The standards of the National Board of Fire Underwriters for the storage of nitrate X-ray film and nitrate sheet and roll film were then strengthened[3].

About this same time research work on cellulose acetate or "safety" film base which the film manufacturers had been conducting for many years made it possible to supply safety X-ray film. The period 1930 to 1940 saw the gradual replacement of nitrate by safety base for most photographic films except motion picture film, amateur roll film, and film pack. Following World War II additional improvements were made in safety film base which permitted most manufacturers to replace nitrate base for these products.

Although the following table applies only to films manufactured by the Eastman Kodak Company, it may be useful as an indication of the approximate time when the use of nitrate film base was discontinued.

Safety film was in general use several years earlier than these dates indicate because the transition from nitrate film was made gradually. At the present time nitrate film base has almost ceased to be used in the United States although a few nitrate films may still be supplied by some manufacturers. The situation is quite different in most of Europe and Asia where nitrate is still the predomi-

Date of Last Nitrate Film Manufactured by the Eastman Kodak Company in the United States	Type of Film
1933	X-ray film
1938	Roll film in size 135
1939	Portrait and commercial sheet film
1942	Aerial film
1949	Film pack
1950	Roll film in sizes 616, 620, 828, etc.
1951	Motion picture film (35mm)*

* 16mm motion picture film was never made on nitrate base.

nant base for photographic film. Of course, the substitution of safety for nitrate film base in manufacturing does not solve the problem of storing existing nitrate negatives.

Film Used in Amateur Still Cameras

Roll film, with the exception of the 135 size, has approximately 0.0035-inch thick support coated on the back with a gelatin non-curling layer. Film packs are generally made with the same type of film as this roll film. The gelatin backing on the film tends to reduce flammability and improve stability.

Film in the 135 size for 35mm miniature camera use is physically the same as motion picture film. It has a base approximately 0.0055-inch thick without a gelatin backing and is cut and perforated similarly to 35mm motion picture film. As a result it was possible for dealers or photographers to buy nitrate motion picture film in bulk and respool it in 135 magazines. For this reason there are probably more nitrate 135 negatives in existence than would otherwise be the case.

Nitrate commercial and portrait sheet film was made on base approximately 0.008-inch thick with a gelatin anti-curl layer on the back.

The difference in base thickness between these several types of film is of practical importance in nitrate film storage because the thicker the base, the greater the amount of cellulose nitrate in the film. The thicker films are more hazardous and more likely to decompose with age.

Hazardous Properties of Nitrate Film

The hazardous properties of nitrate film are described in detail in the literature [4, 5, 6] and are only briefly reviewed here. The most dangerous aspects of nitrate film are:

1) Ease of ignition (including spontaneous ignition).
2) High rate of combustion.
3) Toxicity of combustion products.

The ignition temperature of stable nitrate film is only about 300F compared with 600F to 700F for paper, and 800F to 1000F for safety film. Contact with a heated electric light bulb or a lighted cigarette can cause the ignition of nitrate film. Nitrate films which are unstable as a result of partial decomposition with age or improper storage conditions may ignite spontaneously at temperatures as low as 120F. Spontaneous ignition is believed to be responsible for a number of fires in nitrate motion picture film storage vaults following periods of hot summer weather[5].

Once ignition occurs nitrate film burns so rapidly that it is difficult to extinguish except by concentrated jets of water. Cellulose nitrate contains enough oxygen in the molecule that a fire cannot be stopped by the exclusion of air. The nitrogen oxides and carbon monoxide given off by burning nitrate film are very dangerous if the quantity of film is sufficient to produce toxic or explosive concentrations of gas. Collections of amateur film negatives are ordinarily not large enough to fall in this category.

Still-camera nitrate negatives are much less hazardous than motion picture films, for example, because the former are usually stored in envelopes which reduces the mass of film in intimate contact and decreases the likelihood of decomposition or ignition. Mention has also been made of the advantage of the gelatin backing on some types of roll film and on sheet film. However, the most impor-

tant difference in hazard between amateur and commercial nitrate film storage is the very much smaller quantity usually involved.

Decomposition of Nitrate Film

It is necessary to review some of the factors involved in the decomposition of nitrate film before discussing the storage problem in order that the principles involved will be understood. The chemical stability of cellulose nitrate depends a great deal on how it is made and on its purity. However, the most stable cellulose nitrate decomposes slowly even at room temperature with the evolution of nitric oxide, nitrogen dioxide, and other gases[1].

The decomposition of cellulose nitrate is autocatalytic, the evolved gases acting as catalysts to accelerate further decomposition. This means that as decomposition proceeds the reaction goes faster and faster unless these gases are allowed to escape. This is a very important factor in film storage because it means that the life of nitrate film depends on the ready escape of these fumes. This is one of the reasons why the thicker sheet film negatives are more likely to decompose than roll film or film pack negatives. It also explains why a quantity of film in close contact with itself, as in a roll of motion picture film or a stack of uninterleaved negatives, is more apt to decompose than individual films stored in envelopes where the nitrogen oxides have a better chance to escape to the air.

The rate of decomposition of cellulose nitrate is also very dependent on temperature and moisture content. The temperature coefficient of the reaction is about 4 per 10C or 2 per 10F which means that the rate of decomposition approximately doubles for every 10F increase in storage temperature. Moisture absorbed from the air, the amount of which is determined by the relative humidity, also accelerates the decomposition reaction. The nitrogen dioxide given off by the slow decomposition of nitrate film is a powerful oxidizing agent and also forms nitric acid in the presence of moisture. It attacks the film base, the gelatin of the emulsion, and the silver in the image. The film base gradually becomes yellow, then brown in color, brittle and finally turns to powder. The gelatin is gradually hydrolyzed and degraded until it becomes sticky and is rendered water soluble. The silver image also becomes discolored and faded and finally disappears because of various complex chemical reactions with the cellulose nitrate and gelatin decomposition products. Nitrate film decomposition products will also attack and damage safety films stored nearby.

Cummings et al[5] describe the following five stages of nitrate motion picture film decomposition which are useful for comparison, although the appearance of still-camera negatives may differ from that of film in 35mm rolls. (Fig. 1)

Figure 1. Nitrate 35mm film stored in small rolls illustrating different degrees of decomposition. Left, film in good condition. Center, film in first to second stage of decomposition (film yellow-brown in color and image partly faded). Right, film in fourth to fifth stages of decomposition.

First Stage—Amber discoloration with fading of the picture image.

Second Stage—The emulsion becomes adhesive and the films tend to stick together.

Third Stage—The film contains gas bubbles and emits a noxious odor.

Fourth Stage—The film is soft, welded to adjacent film and frequently covered with a viscous froth.

Fifth Stage—The film mass degenerates partially or entirely into a brownish acrid powder.

Film in the second and third stages of decomposition is often brittle. (Fig. 2) This type of film brittleness is permanent and severe in contrast to the temporary decrease in flexibility which occurs when film is kept at very low relative humidities. The odor mentioned under the third stage is very characteristic of decomposing cellulose nitrate or nitric acid and once known is easily recognized. It is less pronounced but still noticeable in the second stage of decomposition.

Film in the first and second stages of decomposition can be copied photographically but only portions of film in the third stage may be reproducible. Film in the fourth or fifth stages is useless and should be immediately destroyed because of the danger of spontaneous combustion and chemical attack on other negatives.

One other factor concerning the decomposition of nitrate film deserves mention. It is generally believed that faulty processing — inadequate fixing and/or washing — hastens the decomposition of nitrate film. Fixing solutions are generally acidic in nature and it seems reasonable that any acid remaining in the film after processing would certainly tend to speed up decomposition. At the same time there is little direct experimental evidence of the effect of photographic processing on the stability of nitrate film.

The possible effect of processing on the decomposition of nitrate film base should not be confused with the very real effect of processing on the permanence of the photographic image, regardless of whether the support is nitrate base, safety base, or paper. Insufficient fixing or washing causes discoloration and fading of the photographic image with age, particularly under warm humid conditions[7,8]. This and other types of chemical stain which occur on negatives may be confused with the early stages of deterioration caused by decomposition of nitrate base.

There are a number of facts about nitrate film decomposition which cannot be satisfactorily explained. For example, why are some nitrate films 40 or 50 years old still in good condition while others have decomposed to the fifth stage in less than five years under similar storage conditions? Why do nitrate films

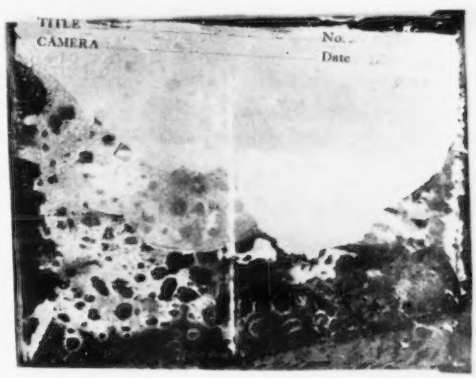

Figure 2. Example of nitrate sheet film negative made in 1925, now in the second to third stage of decomposition. Photograph shows the negative viewed from back by reflected light. Part of original filing envelope was removed but part remained stuck to gelatin backing. The film was very brittle and discolored, the emulsion water-soluble and sticky, and the image partly gone.

of the same source and age in the same storage area differ widely in degree of decomposition? The only safe lesson to be drawn is that one can never be entirely sure how long nitrate film will last. Decomposition is not always gradual, since film which has remained in apparently good condition for many years may badly decompose in the course of another year.

History of Nitrate Amateur Film Storage

Although fires have resulted from the storage of commercial quantities of nitrate X-ray film and professional sheet films, and fires are still occurring from time to time in nitrate motion picture film storage vaults, the author does not know of any fire caused by the storage of nitrate still-camera film negatives in quantities such as the amateur collects. This is largely because of the smaller amount of cellulose nitrate involved and the fact that still-camera negatives are generally stored in envelopes more accessible to the air. Undoubtedly nitrate negatives have caught fire accidentally from carelessness with cigarettes or the like, but we know of no case of spontaneous ignition of this type of film. This is confirmed by the following statement from a letter of Mr. Chester I. Babcock of the National Fire Protection Association, Boston, Massachusetts, to Mr. A. L. Cobb, Safety Director, Kodak Park Works, Eastman Kodak Company, dated September 30, 1952:

> "I have reviewed our files of fire reports covering the last fifty years and find no reports of fires caused by nitrate negatives stored in quantities that would customarily be found in homes or offices where the film was used for amateur purposes. Although our fire record files are not complete, we do have a large volume of fire experience, and I feel that if the storage of small quantities of ordinary nitrate film by amateurs had caused much of any trouble, it would show up in our files."

It is possible, of course, that a fire in a house or office might be started by nitrate film decomposition and that the evidence would all be destroyed in the fire which would then be incorrectly attributed to other causes.

As regards damage to nitrate film negatives caused by deterioration or decomposition of the base, there are also surprisingly few recorded instances. Sheet film negatives on the thicker nitrate base have been found in various stages of decomposition but very few cases of decomposition of roll film negatives have come to our attention.

It may be of interest to cite some specific examples. George Eastman House, 900 East Avenue, Rochester 7, N.Y., which is now a photographic museum, has hundreds of nitrate roll film negatives from Mr. Eastman's personal collection made in 1906-07 and still in good condition. Another collection of nitrate sheet film negatives made in 1920-22 were recently found to contain a number of films in the first two or three stages of decomposition. Small nitrate film collections in other parts of the country are known to have badly deteriorated in much shorter periods, probably because of adverse storage conditions.

The very much better record which has been established for preservation by nitrate amateur negatives compared with motion picture films, undoubtedly, is due to the smaller quantity involved in any one storage area and the practice of keeping still negatives in paper envelopes with better access to the air.

Identification of Nitrate Film

Since different precautions are required for the storage of nitrate and safety film it is important that one be able to distinguish the two types. Where all the negatives in a collection are treated as nitrate film, it is not necessary to identify those that are safety if they are not valuable. However, safety films of value should never be stored with nitrate films and they may be separated by one of the following methods of identification.

1) *Edge Printing* — In more recent years it has become the practice for film manufacturers to print the word "safety" or "nitrate" along the edge of the film, either by embossing or by exposing a latent image which is visible after the film is developed. This was not done in the early years of the industry. A negative which is not edge printed "safety" should be assumed to be on nitrate base unless positive identification to the contrary is established.

2) *A Chemical Test* — For chemists there is the well known diphenylamine test which may be applied to a tiny piece of film trimmed from the edge of the negative. This method is not described here because it is unsuitable for general use. Care must be taken to avoid error caused by the minute amounts of cellulose nitrate sometimes applied to the surface of safety film base to help make the emulsion adhere.

3) *A Float Test* — The specific gravity of nitrate film base is about 1.5 while that of safety cellulose ester types of film base is 1.2 to 1.3. Consequently, if a $\frac{1}{8}$ inch punching from the corner or edge of a negative is shaken in a small bottle or test tube containing an inert liquid of intermediate specific gravity, it will sink if it is nitrate and float if it is safety. Trichlorethylene (specific gravity 1.477) is recommended for this purpose. It is not necessary to remove the emulsion or gelatin backing to make this test but the film should not be wet.

4) *A Burning Test* — Nitrate and safety film can be distinguished by their burning properties but the test must be made carefully because safety film does burn and a small piece of nitrate film burns much less vigorously than a large piece. A piece of film approximately $\frac{1}{8}$ x 1-inch should be trimmed from the edge of the negative. It should be held vertically with tongs or pliers at the lower end over an ash tray (at some distance from other films). The piece of film should then be ignited with a match at the top. If the film is nitrate it will burn rapidly and vigorously downward with a bright yellow flame until completely burned; if the film is safety it will ignite only with difficulty and the flame will usually go out shortly after the match is removed. If ignited from below, safety film may burn completely. Unless one is experienced, this test should be tried first on nitrate and safety films of known identity so that the behavior of both types will be understood.

Storage Recommendations for Nitrate Negatives

Fire Prevention

The standards of the National Board of Fire Underwriters and the National Fire Protection Association for the storage of nitrate films apply primarily to the commercial storage of films in quantities of the order of 100 to 1000 pounds or more, rather than to the small quantities usually collected by amateurs. The only regulations which might be interpreted as applying to amateurs are those in paragraph 21 of the standards[3], namely,

(a) "Storage of film negatives in basements is prohibited."

(b) "Film negatives in storage or in process of handling shall be kept in heavy manila envelopes, not exceeding twelve films to an envelope. Expanding envelopes shall not be used."

The National Fire Protection Association standards specify that nitrate film shall be stored in approved insulated metal cabinets vented to the outside, and equipped with an automatic water sprinkler. Not more than 250 pounds is permitted in any single cabinet, and if the quantity exceeds 1000 pounds it must be stored in an approved vault.

No lower limit for the quantity of nitrate film requiring approved storage cabinets is stated in the standards. It is the author's opinion that several pounds of nitrate film represents a reasonable limit where proper precautions are taken. Where any appreciable quantity is stored, the standards of the National Fire Protection Association should be followed.

The risk of fire is not so great for small quantities of nitrate film and it is probable that few people take any special precautions. However, even a small chance of fire should be avoided and a few simple precautions are recommended. The films should be placed inside well vented small metal boxes or cans each of which is stored in a separate vented box made of Transite, plaster board, or similar non-combustible insulating material. An alternative plan is to construct simple sectionalized shelves, and line each compartment with the non-combustible insulating material. Each can of film should be stored in a separate insulated compartment. The storage location should be away from any source of heat such as radiators, chimney, hot air ducts, light bulbs, etc., and proximity to readily combustible materials such as curtains, clothing, paper, etc. should be avoided. In the event of spontaneous combustion of the film in any one container, the chance of the fire spreading will then be extremely small.

Film Preservation

The National Fire Protection Association standards for the storage of nitrate films are concerned with the prevention of fire and injury, not with preservation of the film. Where nitrate film negatives of value are being stored additional precautions should be taken for their preservation as outlined below. More information may be found in the literature[9,10,11].

1) *Classification*—Negatives should be classified according to their value since this determines the trouble and expense which their care justifies. Such a classification might include negatives of passing interest, those of moderate value, and those of historical interest or great value. Safety film negatives of value should be completely segregated from nitrate negatives because fumes from decomposing nitrate film can ruin safety negatives when they are stored together.

2) *Processing* — All films which are to be preserved for any length of time must be thoroughly fixed and washed because residual processing chemicals may cause staining and fading of the photographic image[7]. However, old nitrate negatives which were improperly processed should not be rewashed because, if partial decomposition has occurred, the gelatin in the emulsion may have become solubilized so that water will destroy the image. Any nitrate negatives under suspicion should be copied on safety film and the originals destroyed. More recent nitrate negatives known to be insufficiently fixed or washed can be refixed and rewashed if a trial at the corner of a nega-

tive indicates that the emulsion is still water insoluble.

3) *Envelopes* — Film negatives should be stored in envelopes, not over six negatives per envelope, and preferably only one. Nitrate roll film negatives, including 35mm, should not be stored in the form of rolls because this retards the escape of nitrogen oxide fumes. The negatives should be cut apart or the film cut in strips for envelopes. (Fig. 3) The envelopes used should conform to the requirements of the American Standards Association standard, "Photographic Filing Envelopes for Storing Processed Photographic Films, Plates, and Papers", Z38.8.21—1950, obtainable from the American Standards Association, 70 East 45th Street, New York 17, N.Y. The essential requirements for negative envelopes are that the paper and adhesives used be free from harmful impurities and that all seams be along the edge rather than down the center. (Fig. 4)

4) *Atmospheric Conditions* — The most satisfactory conditions for the storage of nitrate film negatives are about 50 F and 40 to 50% relative humidity. However, these conditions are not always easy to obtain. The most important requirements are that relative humidities over 60% and temperatures over 80 F must be avoided, since these conditions promote the decomposition of nitrate film. Lower relative humidities favor nitrate stability but below about 25% relative humidity the gelatin in the emulsion is brittle and the film is more apt to crack if roughly handled. This type of brittleness is not permanent and flexibility is regained when the relative humidity rises.

In temperate climates, storage on the main floors of buildings away from outside walls, heating pipes, etc., is normally satisfactory. Basements are usually damp and attics are usually hot in certain seasons of the year and neither of those locations should be chosen for film storage. Where maximum life is desired for valuable films in archives and museums, air conditioned storage at approximately 50 F and 40 to 50% R.H. is recommended. If film is stored below room temperature it should be kept in a closed container when withdrawn from storage until its temperature has risen above the dewpoint of the outside air. This is to avoid any moisture condensation on the film.

Figure 3. Envelopes for storing two 35mm film strips.

In very humid or tropical climates, the preservation of nitrate film for any length of time is a difficult problem without modern air conditioning facilities. Refrigerators, particularly those containing foods, are generally too humid. If the film is dried in some manner and then sealed in

Figure 4. Album with individual folders.

a container to prevent the entry of moist air, the escape of nitrogen oxide fumes is prevented. Under such conditions the best compromise is to store the film negatives along with activated silica gel in a can with a slip-on cover, sealing the lid with adhesive tape and placing the can in a refrigerator or other cool location. (Activated silica gel can be purchased from chemical supply houses and some photographic dealers with instructions concerning exhaustion and reactivation.) The silica gel serves a double purpose by absorbing some of the nitrogen oxide fumes evolved from the base as well as moisture present in the film.

If the films are already at a high equivalent relative humidity they should be separated in some way so that the drying effect of the silica gel will be reasonably uniform. Approximately two to three ounces of activated silica gel are required to dry each pound of film and paper from an equivalent relative humidity of 80% to 40%. An alternative method is to pre-dry the film by spreading out the envelopes containing negatives on a rack in a simple drying cabinet for one to two hours. Air should be heated just enough to reduce the relative humidity to about 40%, and circulated over the film. The films should then be sealed with silica gel and stored as described above.

Another factor concerning air conditions which should be considered in film storage is contamination from small amounts of hydrogen sulfide and sulfur dioxide which are frequently present in industrial gases, illuminating gas, etc. These contaminants can cause gradual fading or sulfiding of the photographic image with either nitrate or safety film.

5) *Inspection* — One of the most important precautions to be followed in preserving nitrate films is regular inspection. This should be done at least once a year unless decomposition is suspected or adverse climatic conditions are unavoidable, in which case inspection should be every six months or oftener. At the first sign of decomposition — yellow discoloration, fading, odor of nitric acid fumes, brittleness, stickiness of the emulsion, etc. the suspected negatives and those adjoining should be removed from the collection, copied on safety film if desired, and then destroyed.

The signs of nitrate film decomposition are not always dependable in the early stages. Yellow discoloration and fading may be due to improper processing or atmospheric contaminants and may occur with safety film as well as nitrate. On the other hand, nitrate film decomposition may be well advanced before it is ordinarily detectable.

Stability tests which require only a 1/4-inch punching from the negative may be made to assist in the detection of nitrate film decomposition (See Appendix). These tests indicate the iminence of serious decomposition so that a copy on safety film can be made while there is still time. A small amount of apparatus and some chemical laboratory experience is needed to make stability tests but this practice is highly recommended where valuable records exist on nitrate film and it is not practical to duplicate them all on safety film.

Copying valuable nitrate negatives on safety film does not mean that all storage precautions can then be completely relaxed[12]. Safety film has no fire hazard; it is chemically stable and does not decompose with age as does nitrate film. However, safety film can be damaged if improperly processed, if stored in some types of envelopes, or if stored under very humid conditions.

Conclusions

It is impossible to predict the life of nitrate films. Much depends on the history of the particular film — its manufacture, processing, and the particular storage conditions to which it has been subjected. Nitrate films may decompose in less than five years under some conditions, but with proper care a life of many years may be expected. Nevertheless film records of permanent value must eventually be copied on safety film if they are to be preserved indefinitely. This should be done gradually while the originals are still in good physical condition.

The statements and recommendations in this paper are made in an effort to help amateurs in the safe storage and preservation of their nitrate negatives. They are based upon what we believe are the best sources of information but on account of the varying properties of different makes and types of film and the different circumstances under which they may be kept, we cannot make any guarantees that no accidents or image loss will occur.

Summary

The storage of nitrate still-camera film negatives in the quantities normally collected by amateur photographers is not considered dangerous provided that simple precautions are taken. The National Fire Protection Association has no record of such films ever having caused fires in homes. For quantities of film greater than several pounds an approved storage cabinet should be used as required by the standards of the National Fire Protection Association.

A brief history of nitrate film storage is given and film decomposition with age is described. Storage recommendations are made which include considerations of film preservation as well as fire prevention. It is not possible to predict the life of nitrate negatives but, with proper care, they should last for many years. Copying the most valuable negatives on safety film can be done gradually while the originals are still in good physical condition.

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Note: References number 6, 8 and 12 may be obtained from the Eastman Kodak Company, 343 State Street, Rochester 4, New York.

APPENDIX*

Film Decomposition Tests

RECENTLY the attention of film librarians was directed to two stability tests developed in England, under the auspices of the British Government's Chemical Research and Development Establishment and the Department of the Government Chemist. In Report No. 2/R/48, "The Surveillance of Cinematograph Record Film During Storage," by G. L. Hutchison, L. Ellis, and S. A. Ashmore, the authors described a rather extensive investigation of the stability of film in storage and outlined the details of two test procedures which they have found useful. Further information concerning the use of these tests and the results obtained may be secured from the British Film Institute, 164 Shaftesbury Ave., London, W.C.2, England. This is an organization maintained in part by a grant from the British Government.

Recommended Tests

Two recommended tests for predicting the future condition of nitrate film in storage are the Alizarin Red Heat Test and the Micro-Crucible Test. These are described briefly below:

Alizarin Red Heat Test

In this test a small punching of the film of approximately 6 mm diameter and weighing 7 mg is heated in a glass tube in which is suspended an alizarin red test paper moistened with a solution of glycerine in water. The tube is heated at a temperature of 134 C and the time noted for the development of acid vapors as indicated by a color change in the test paper.

1. Apparatus

(a) Glass tube closed at one end and approximately 90 mm in length and 9 mm internal diameter is fitted with a stopper 60 mm in length and of such a diameter that when covered with one thickness of test papers makes a close sliding fit in the tube. 45 mm of the stopper should then be in the tube.

(b) A cylindrical double-walled copper air bath, 100 mm deep and 100 mm in diameter. The metal lid is lagged with asbestos composition 8 mm thick and contains a central hole to take a thermometer and six holes, of 12-mm diameter, suitably arranged to take six testing tubes. The outer jacket of the bath is fitted with a reflux condenser.

(c) A supply of rubber rings to give convenient support to the tubes in the air bath.

(d) A supply of large size filter papers (Whatman, No. 2).

2. Preparation of the Test Paper

This is conveniently prepared by impregnating a sheet of filter paper with a 0.1% solution of alizarin red indicator in water to which has been added 2 ml of 2 N ammonia per 100 ml. The solution is allowed to drain off and the edges of the paper are subsequently discarded. The paper may then be air dried but should be further heated for 10 min in the steam oven before use, to drive off any traces of free ammonia.

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3. Method

The outer jacket of the bath is charged with about 20 ml of pure xylene and heat is applied by means of a small gas burner. When temperature conditions are steady the thermometer should read 134 C.

In the meantime six tubes, as described at (a) under Apparatus, are prepared for test. Into each is placed a punching of the film under test, the punching being 6 mm in diameter and weighing about 7 mg. A strip of test paper is cut to such a width that when wrapped around the stopper the whole of the latter is effectively covered without any overlap which would spoil the snug fit in the tube. The test paper is then moistened with a 50% solution of glycerine in water. Each tube is fitted with a rubber ring, the position of which is adjusted so that the part of the tube containing the test paper is wholly outside the bath.

With all tubes in position in the bath the temperature and time are noted. The tubes are kept under constant observation, if necessary for rather more than one hour.

The color of the test paper prepared as described is maroon, which, in the presence of acid vapors, is either bleached or becomes a pale yellow. The change is well marked and readily observed: for the purposes of this test, the time in minutes required for a positive result is taken when the lower edge of the paper is bleached or changed in color to a distance of approximately $\frac{1}{8}$ in.

Note 1.

The apparatus described can suitably be increased in size so that more than six samples can be tested at one time.

Note 2.

If a tube is removed after test while the other tubes are in position, the vacant hole must be closed with a cork or bung.

Micro-Crucible Test

This test involves the determination of the loss in weight of a punching of cinema film when heated in a small porcelain crucible in a ventilated oven maintained at 100 C.

The crucibles are of 1 ml capacity and are obtainable from Royal Worcester Porcelain Co., or indirectly through laboratory supply firms.

A disc of film of approximately 0.25-in. diameter and weight about 7 mg is punched out of the film in question and transferred to the crucible weighed to the nearest 0.01 mg. The combined weight of crucible and film is then determined accurately, also to 0.01 mg, and the weight of film found by difference.

The crucible and film are then heated in a ventilated oven maintained at 100 C and the combined weight determined at 168 hr and 300 hr. The loss in weight is then calculated as a percentage on the original weight of the film.

RESULTS		SENTENCE
Alizarin Red Heat Test	*Micro-Crucible Test* (after 168 hr)	*Retest after:*
60 min and over	—	2 years
Under 60 min but not under 30 min		1 year
Under 30 min but not under 10 min	Under 10%	6 months
Under 10 min	10% and over	Copy and destroy

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Infrared Photomicrography with the Electron Image Converter Tube*

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Introduction

INFRARED film became commercially available in 1931. Since then it has found many uses. Infrared photography[1, 2] has proved useful in the study of varicose veins, superficial tumors, cirrhosis and thrombosis of blood vessels. It is of value in any condition where the opacity of the skin prevents making clear photographs. Tholl[3] has used infrared contact photography for the examination of questioned documents. This method can be utilized in other fields such as criminology, philately, and botany. Infrared film is used for distant haze penetration and to produce various effects in commercial, architectural and landscape photography. It is used to detect camouflaged installations during air reconnaissance. (Much effort has been expended toward matching the infrared reflectance properties of textile fabrics, paints and building materials with those of natural substances such as chlorophyll and mineral substances.) Infrared photography has been used for weed control and defoliation research to detect when chlorophyll is inactive[4]. Additional applications are given in the summary.

Infrared Photomicrography

Infrared sensitive plates and films have been used successfully in photomicrography[5, 6, 7]. Many substances that are strongly absorbing or opaque in the visual range are relatively transparent to infrared. Thus the infrared sensitized emulsion transforms the invisible infrared image into one that is visible. Although use of infrared in photomicrography entails decreased resolving power, the photomicrographs often are more revealing of structure. Such photography is limited to that portion of the infrared spectrum which is transmitted by the glass lens system of the microscope, and is also limited by the spectral response of the emulsion. Infrared photographic material is available for the wavelength range of 800 to 1200 millimicrons. This is the near infrared region, which glass lenses transmit sufficiently for photography. Lens systems have become available for transmitting longer infrared wavelengths.

An ultraviolet translating microscope has been developed by E. H. Land of the Polaroid Corporation. This instrument transforms an ultraviolet image into a colored image, the color of which can be related to the ultraviolet transmittance characteristics of the substance under observation. The same could, undoubtedly, be worked out for the infrared, or for any region of the electromagnetic spectrum.

* Presented at the 22nd Annual Meeting, New York City, 1952.
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Whereas the use of a photographic emulsion as a detector is an ideal way of recording what the eye cannot see, certain difficulties are sometimes encountered. With opaque subjects, for example, it is difficult to know what to photograph or where to focus. The infrared converter tube becomes an invaluable aid in such instances. The development of the infrared image converter tube has made it possible to view the effects of infrared radiation out to about 1300 millimicrons directly. Where photomicrography is required, the image formed on the phosphor-coated screen portion of the tube may be photographed directly with ordinary film or, infrared sensitive material may be substituted for the image converter tube by suitable optical means.

Figure 1. British Service Tube CV144.

Electron Infrared Image Converter Tube

Figure 1 shows the early British tube manufactured according to the British patent No. 326,200 issued to G. Holst. It is the simplest type manufactured, and the type used in this laboratory. It is perfectly satisfactory for infrared image conversion, but not satisfactory for some applications to be discussed later. The tube was developed for the British armed service as early as 1940. The top and bottom windows are optically flat. Electrons are emitted at the bottom window and pass to the phosphor-coated plate, 5mm above.

Figure 2 is a diagram of the tube. This tube requires 4,000 to 6,000 volts for operation. Infrared radiation falling on the semi-transparent silver-caesium oxide photocathode will release electrons in proportion to the amount of radiation. These electrons are accelerated by the application of the high voltage and travel in straight lines to the phosphor-coated anode, or fluorescent screen as it is called here, where they form a fluorescent image corresponding to the infrared image.

The high voltage required may be supplied by a 4,000 to 6,000 volt neon-sign transformer. A dry voltaic battery, such as the *Zamboni* pile, or a vibrator power unit, also have been suggested as sources for the high voltage. The power supply

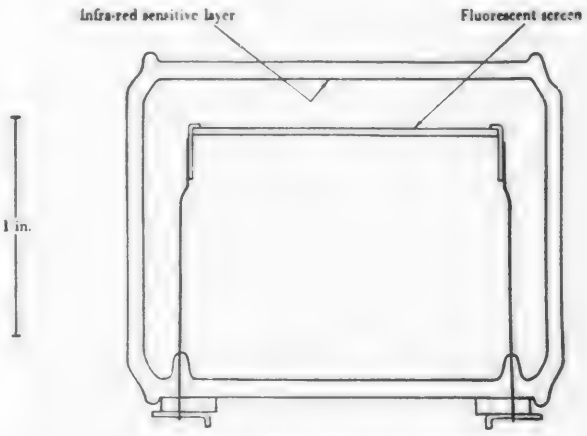

Figure 2. Diagram of British Service Tube CV144.

used in this laboratory* is shown in Figure 3. Since very low current is required for operation of the tube, it is desirable for safety reasons to use a low-current power supply such as the one shown here. This is an RF supply with high internal impedance.

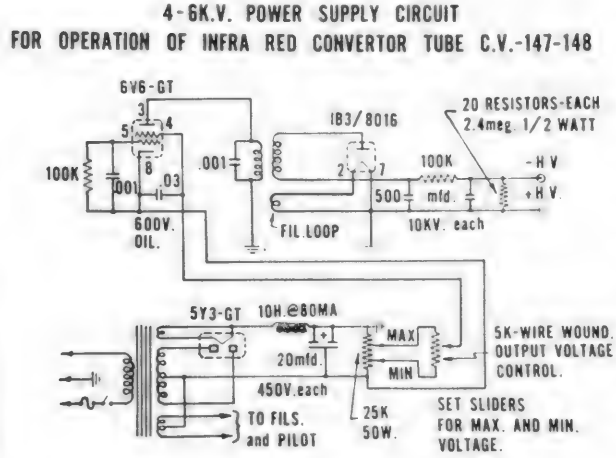

Figure 3. High voltage, low current power supply for British Service Tube CV144.

Other applications of the electron image converter tube have been discussed recently by R. F. Lawrence and Kenneth Shaftan[8], and by J. A. Jenkins and R. A. Chippendale[9]. The use for wavelength conversion has already been mentioned. The cathode composition can be chosen to make the tube sensitive to any electromagnetic radiation from x-rays to infrared rays, therefore, images produced on the cathode by a wide range of invisible radiations can be seen or photographed at the fluorescent anode position. A second use, namely, image intensification, is a natural follow-up. For a 1:1 ratio of the size of the image falling on the cathode to the size of the image on the fluorescent anode, the image is intensified approximately 10 times for an electron acceleration of 5 kilovolts. The third use, namely, as a fast shutter, is a bit more subtle, but very interesting. By the insertion of a grid into the tube that controls the flow of electrons from the cathode, the tube can be used as a fast optical shutter. The Kerr cell has been the most widely used shutter for high-speed photography to date. Exposures of 10^{-7} second have been made with it. The image converter is also capable of 10^{-7} second exposures, and much improvement is expected in its efficiency along these lines. By use of suitable external deflector coils, the electron beam in the image converter can be moved or smeared out across the fluorescent screen, and in this way, records similar to those produced with drum cameras can be obtained. By simultaneous shuttering and scanning, a series of pictures can be produced on the fluorescent screen, for example, six pictures in two rows of three. This can be used to reduce the rate at which a film must be moved to record a movement under observation. Separations of time can be recorded of the order of 0.01 microsecond.

Another type of tube made in this country is the RCA *1P25*. Figure 4 shows a diagram of this tube (upper

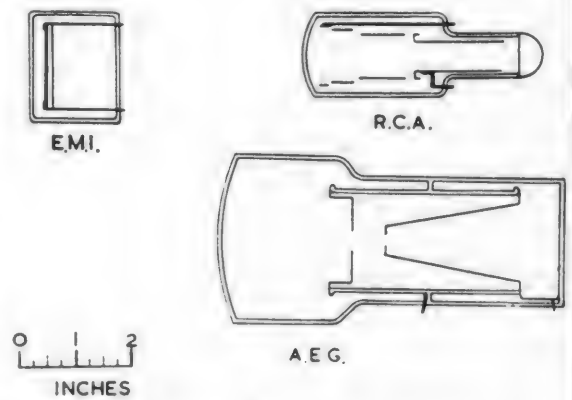

Figure 4. American, British, and German electron image converter tubes.

* Designed by Charles W. Warren, Consulting Engineer, 37 Mali Drive, North Plainfield, New Jersey.

right) along with the early British, American and German tubes. The German tube (lower right) was not available in this country. The *1P25* has a complicated electrostatic lens system. The left side of the tube is the cathode which emits electrons when excited by infrared radiation. Additional electrodes, variously placed within the tube for reducing pin cushion distortion, focus the electron image on a small phosphor-coated plano-convex lens. Voltages of 15, 100, 600, and 4,000 are required for proper focusing of the electron image. This is the type of tube used by McCrone[7] at the Armour Research Foundation in Chicago for infrared photomicrography, and by Bausch & Lomb for an experimental model, described later.

Investigators in America have used the RCA *1P25* to take single shot exposures at 2×10^{-6} second. The main difficulty with this tube, when used as a fast shutter, is the light leakage through the tube. To overcome fogging, an infrared filter may be used in conjunction with orthochromatic film. It was found impossible to get sufficient radiation onto an object to record at speeds faster than 2×10^{-6} second.

New tubes have recently been designed for high-speed photographic applications. These are the so-called *Mullard Tubes*, one of which is shown in Figure 5. Their construction is shown in detail in Figure 6. The photocathode and screen are on optically flat end plates. The grid electrode, which consists of a layer of aluminum on glass, can be seen inside the tube. Three image converter tube types are manufactured. The *ME 1200* series provides for a photocathode of 30mm diameter and a viewing screen of 115mm diameter. This is a diode tube with photocathodes sensitive to daylight and blue radiation

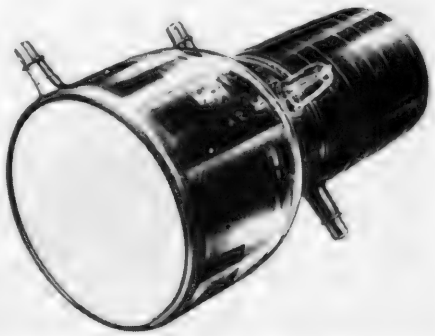

Figure 5. Mullard ME 1201 image converter tube.

or to incandescent and near infrared radiation. The *ME 1201* is a triode image converter especially designed for high-speed photography. This tube provides for a 25mm diameter photocathode and a 115mm diameter viewing screen. The *ME 1202* series tube is a 1:1 magnification diode tube with photocathodes sensitive to daylight and blue radiation or to incandescent and near infrared radiation. The effective diameters of photocathode and phosphorescent screens are 28mm. These tubes are considerably larger than the others described here. The tubes are available with both the Sb-O-Cs and Ag-O-Cs types of photocathode elements. Figure 7 shows the relative spectral sensitivities of these types of cathodes. The Cs-O-Ag layer is sensitive to wavelengths longer than 8,000A,

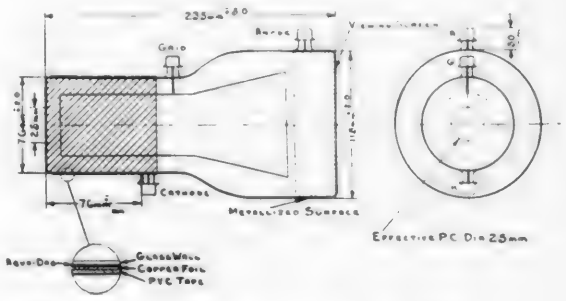

Figure 6. Diagram of Mullard ME 1201 image converter tube.

which enables a conversion from infrared to visible radiation. Since most of the high intensity light sources for high-speed photography peak at about 4,200A, the Ag-O-Cs photocathode is not suitable. The Sb-O-Cs, blue sensitive type, is recommended.

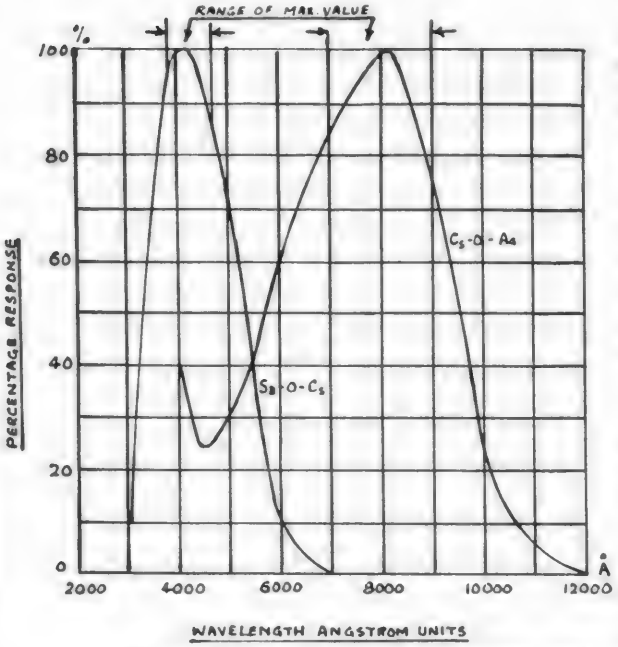

Figure 7. Spectral response of photocathodes.

The power supply and tube housing for the *Mullard* converter are made by Winston Electronic Ltd. and are distributed in this country by J. A. Maurer, Inc. Figure 8 shows the standard image converter tube with a 25mm photocathode and a 115mm viewing screen along with the *IC3* unstabilized power unit.

Image Converter for Infrared Photomicrography

The different uses of the image converter tube are all of considerable importance, but the application of the tube for wavelength conversion is of the greatest benefit in microscopical studies.

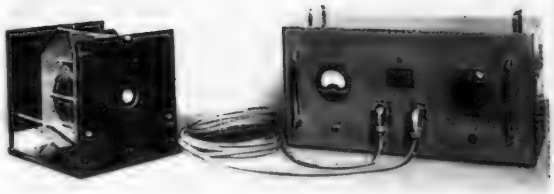

Figure 8. Winston infrared image converter system showing on the right the Type IC3 converter power unit (unstabilized) and on left the mounted Mullard Tube ME 1202CA.

The Bausch & Lomb infrared photomicrographic unit mentioned before is shown in Figure 9. The RCA *1P25* tube is used. An attachment fitting between the microscope proper and the camera, as well as the power supply, are shown in the foreground. The infrared image is split by means of a prism above the ocular into two beams, one directed to the camera loaded with an infrared sensitive material, and the other to the electron image converter tube located in the side arm. The end of this arm contains the small lens used to enlarge the image produced on the small screen of the RCA tube. Such an apparatus, wherein the tube is used only for viewing and focusing, is the ideal set-up, as will be shown later.

Figure 10 shows a good dispersion of phthalocyanine blue pigment photographed with the Bausch & Lomb apparatus. For visual microscopical observation, highly diluted dispersions usually must be prepared due to the high tinctorial value and high hiding power of pigments. In making the dilutions the aggregates present become widely separated and may often be overlooked. By use of infrared, sufficient transparency is attained even for thick dispersions, so that only the aggregates appear. In this way a much better idea of the number and size of aggregates present can be

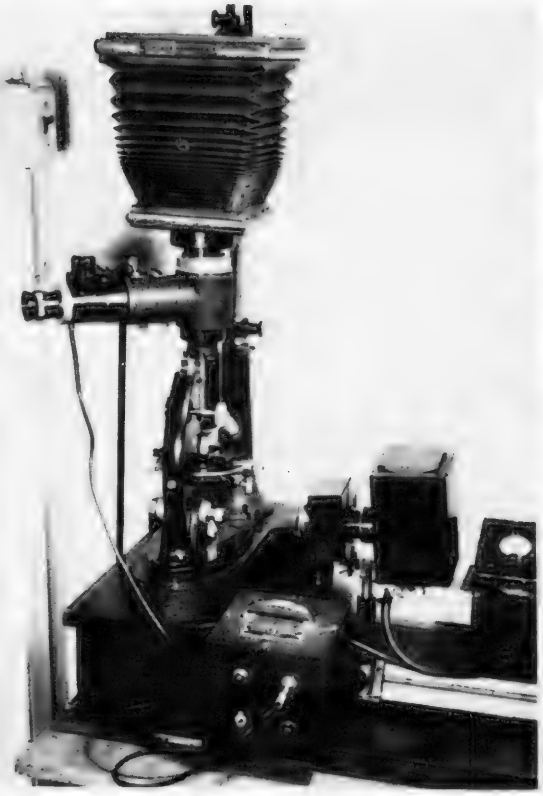

Figure 9. Bausch and Lomb infrared image converter.

obtained. Figure 11, also taken with the Bausch & Lomb equipment, shows another sample consisting of large aggregated pigment. Some idea of the internal structure of these aggregates is obtained from such studies. Both of these pigments were in an excellent state of subdivision when originally prepared. After drying, the one sample remained well dispersed while the other showed severe aggregation which indicates the possibility of intermediate gel formation prior to actual drying out. By visual microscopical examination, only an opaque object is seen. Eastman Kodak *IL Spectroscopic Plates* were used for taking Figures 10 and 11.

The original apparatus set-up in this laboratory is shown in Figure 12. The

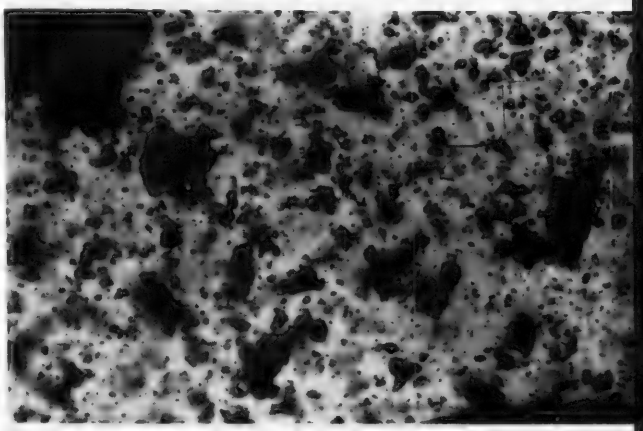

Figure 10. Phthalocyanine blue pigment. A good dispersion, photographed at 600X magnification.

tube is contained in a *Bakelite* case attached in the camera position of the *Micro-Ibso* attachment. The plastic electron tube case is made of two sections, the cup itself and the screw cap type cover. Both cup and cap contain slots through which flat conductors are inserted for connection to the high voltage and ground terminals of the electronic tube. A camera with a 3 inch Wollensack lens is placed above the opening of the screw cap cover. It is not necessary to use infrared sensitive film, for the fluorescent image on the phosphor-coated

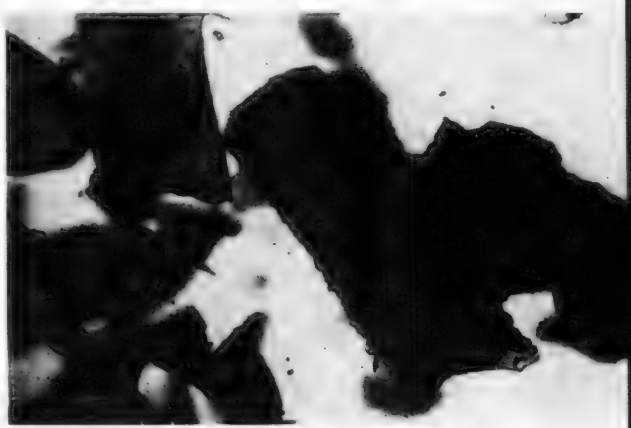

Figure 11. Phthalocyanine blue pigment. A poor dispersion, photographed at 600X magnification.

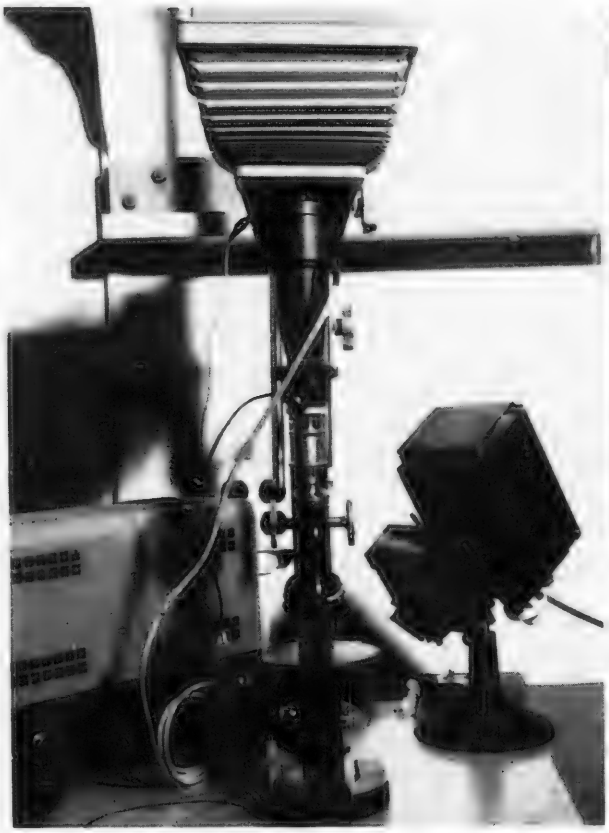

Figure 12. Original Calco infrared image converter apparatus for photomicrography.

portion of the tube is photographed directly. The power supply is shown on the left. The intensity of the image on this screen may be increased or decreased within limits by varying the voltage from 4,000 to 6,000 volts. The microscope is grounded for added precaution.

A 6-volt tungsten ribbon filament lamp is used as a source of infrared radiation. In the examination or photomicrography of visually opaque objects, it is usually preferable not to use a filter over the light source, except possibly a Wratten A (No. 25) to remove the blue end of the spectrum. In some special cases, it may be necessary to use a filter to remove all visible light, such as a Corning No. 2540.

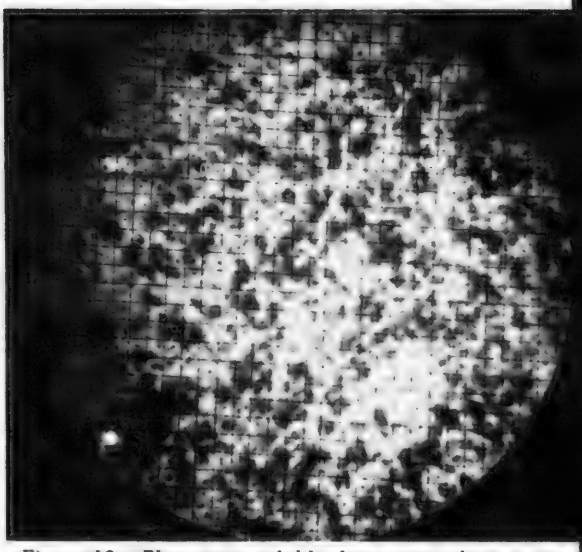

Figure 13. Blue water-soluble dye press cake. A good dispersion. Image on phosphor-coated screen photographed directly at 600X.

Figure 13 shows a blue, water soluble dye press cake in good state of subdivision. Water wet dye press cakes occasionally contain objectionable aggregates, and the samples cannot be diluted with water due to their solubility. By means of infrared photomicrography, these aggregates or grouping of particle are readily detected. Figure 14 shows a second example, containing many large aggregates. By ordinary optical microscopy both samples appear completely opaque. The grid which appears in the photomicrographs was etched on the phosphor-coated plate of the electron image converter tube. Figure 15 is a photomicrograph of the wing covering of the beetle called the Metallic Wood Borer (*Buprestidae family, Dicerca genus*). The resolution on all of these photomicrographs is rather poor. This is the most serious limitation of photographing the image of the tube itself, and is not the best procedure.

Figure 16 shows the apparatus better suited to photomicrography. As for the

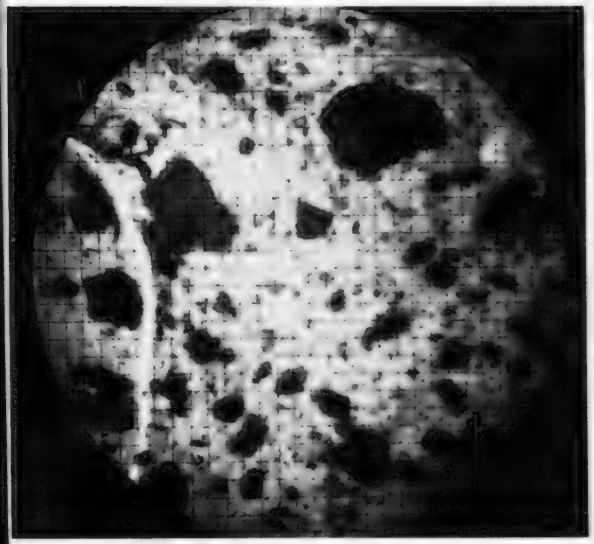

Figure 14. Blue water-soluble dye press cake. A poor dispersion. Image on phosphor-coated screen photographed directly at 600X.

Bausch & Lomb instrument, the infrared converter tube is used only for examination and focusing purposes, and the photography of the infrared image is carried out directly. A prism is located just above the objective of the microscope. One-half of the light passes to the infrared image converter tube in the side arm, whereas the other half passes directly to the infrared sensitive film in the camera above the ocular position. The film and fluorescent screen of the image converter tube are in simultaneous focus. The film used is Eastman Kodak *Infrared Sheet Film*. A Wratten A filter (No. 25) over the light source absorbs the blue light to which the film is sensitive. A prism in the side arm is located just above the objective.*

Figure 17 illustrates a moth wing. The horizontal structure is due to the scale pores in the wing. Although this specimen was not entirely opaque to visible light, the pores were not visible unless the scales were removed. The exposure required was about 20 seconds. Figure 18 shows the wing covering of the Metallic Wood Borer in which great detail is evident. This wing was almost completely opaque when visually examined by light. The electron infrared image converter tube permitted very careful focusing so that the micrographs could be prepared with no difficulty. Two minute exposures on Eastman Kodak *Infrared Film* were required. One can get a good idea about the exposure from the intensity of the image on the converter tube.

Difficulty is occasionally encountered in the clogging of ink used in ball point pens. The opacity of these inks requires that microscopic examination be done by infrared. Figure 19 shows a photomicrograph of a layer of such an ink about 1/16th of an inch thick. The aggregates causing the clogging are clearly visible. One gets not only an idea of the size, but also the morphology and structure of the particles which permit one to speculate on their origin. Figure 20 shows an ink

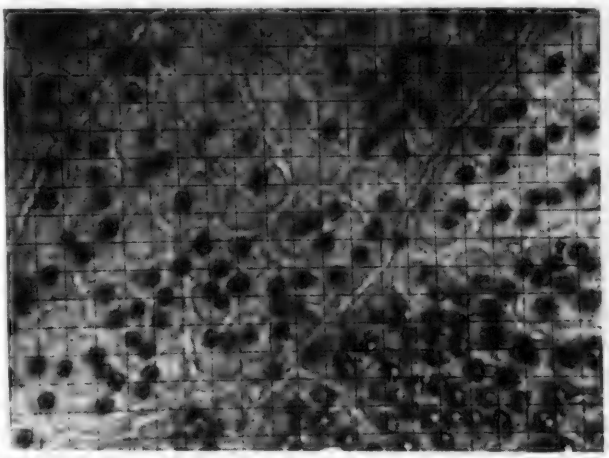

Figure 15. Metallic Wood Borer (Buprestidae-family, Dicerca-genus) wing covering. Photographed directly from screen at 150X.

* Since the presentation of this paper the Gamma Instrument Co., Inc., 378-380 Great Neck Road, Great Neck, L.I., N.Y. has announced the availability of a commercial unit for infrared microscopy with an image converter.

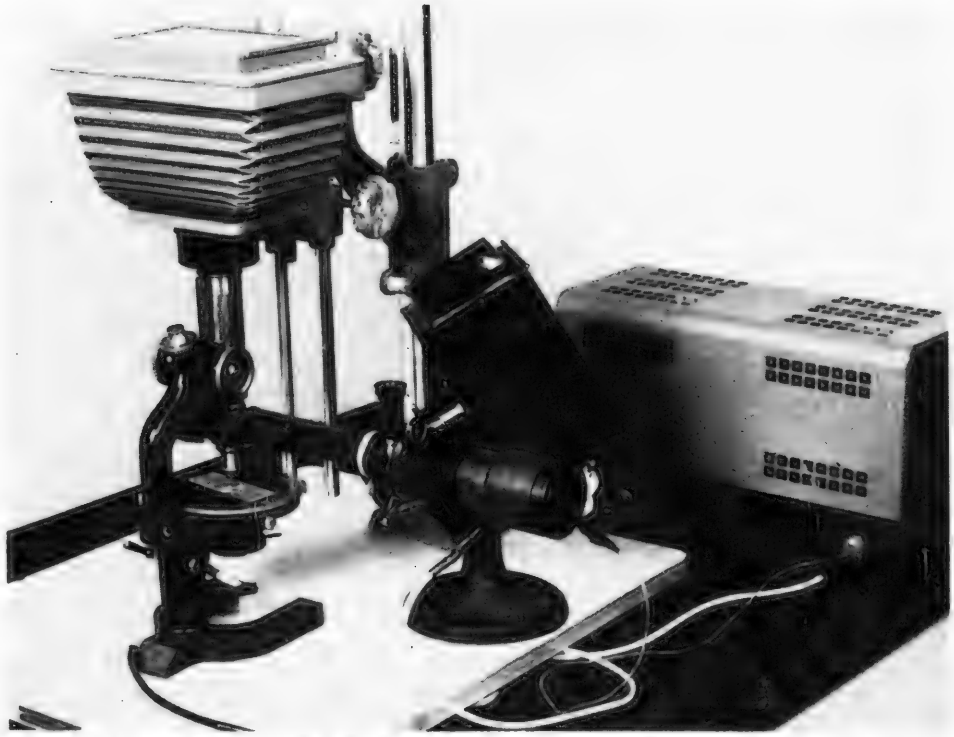

Figure 16. Infrared image converter apparatus for photomicrography.

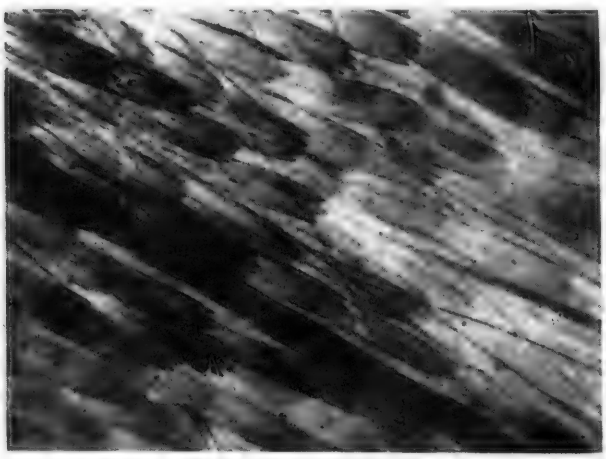

Figure 17. Lepidoptera wing. Photographed directly on Kodak Infrared Film at 150X.

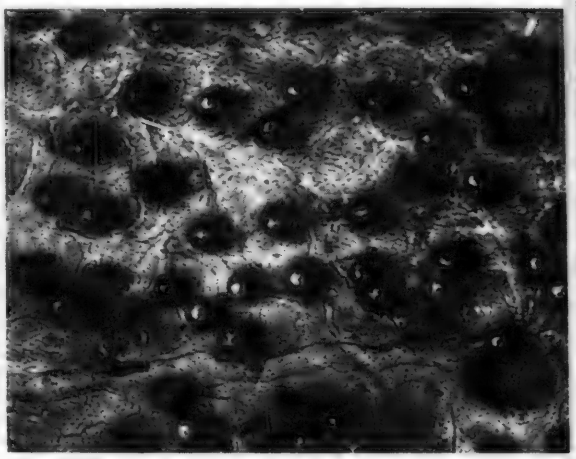

Figure 18. Metallic Wood Borer (Buprestidae-family, Dicerca-genus) wing covering, photographed directly on Kodak Infrared Film at 150X.

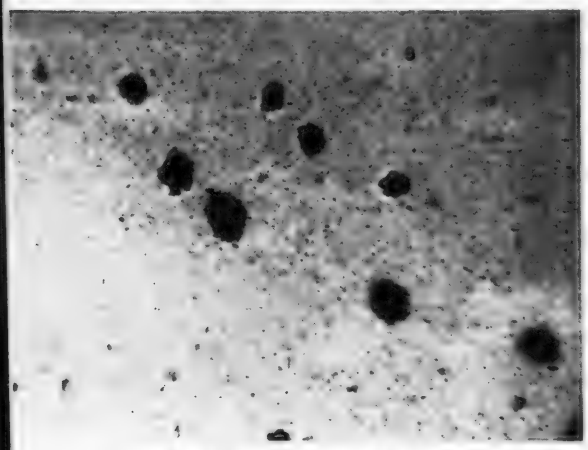

Figure 19. Ball point ink containing aggregates. Photographed directly at 100X.

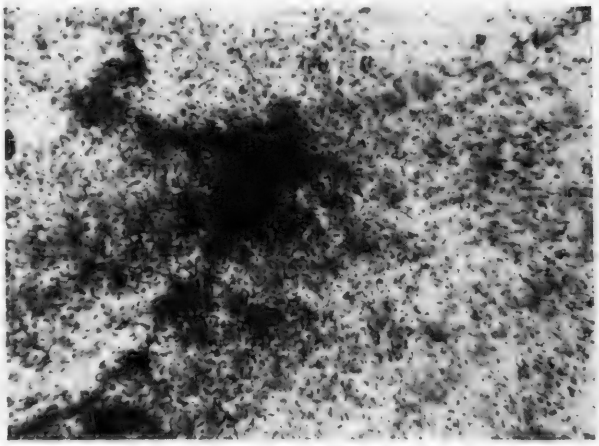

Figure 20. Ball point ink, fair dispersion. Photographed directly at 100X.

that does not contain large aggregates, but it still contains localized concentrations of color.

Summary

The use of the infrared image converter tube has proved to be an invaluable aid in infrared photomicrography. Its use eliminates much of the trial and error usually associated with the photography of images not seen directly by the human eye. The tube should certainly find uses in other types of photography. For example, photography of animal behavior in the dark is made possible with this device. It has been used for observing rats in the dark in the course of an investigation of the spreading of scrub typhus in the Far East and for observing the behavior of malaria carrying mosquitoes in the dark over water. It has been used in an investigation on the sensitization of the retina to infrared radiation and in the study of certain cases of corneal opacity.

It is hoped that this description of the use of the image converter tube in photomicrography will stimulate further applications.

Acknowledgments

The author is grateful for the assistance and encouragement of fellow members of the laboratory in the preparation of the material for this paper, namely, Dr. G. L. Royer, Mr. R. R. Krammes, Miss F. Gustafson, Mrs. P. Buhl and Miss E. Meyer. Figures 8 and 9 were obtained through the courtesy of J. A. Maurer, Inc. and Figures 5, 6, and 7 through the courtesy of Mullard, Ltd. The use of the Bausch and Lomb infrared image converter unit is also gratefully acknowledged.

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A Time-Lapse Cinephotomicrographic Apparatus*

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Introduction

THE growth, mitotic activity, and movement of cells and cell groups in tissue cultures take place at too slow a pace for adequate or accurate visual observation or for motion picture photography at normal rates of speed. Whereas the normal time for a single mitosis is 20 to 90 minutes, some atypical malignant cells require 24 hours to divide. To record a single mitosis, then, might require the continuous operating of a camera for long periods of time, with the end result of an enormously lengthy film that not even the most enthusiastic investigator would sit through for purposes of evaluation. Thus, it was considered a necessity for the *Cell Physiology Laboratory* of the *Department of Surgery* to have a time-lapse cinephotomicrographic apparatus.

The design of the apparatus was influenced by 1) budgetary restrictions, 2) the need for simple operation, since it was known that the apparatus would be operated generally by people not trained in photography.

Tissue Culture Problems

Because of the exacting physiological requirements of tissue culture material, many problems not ordinarily encountered in photomicrography, are found. Briefly, living tissue cultures have the following characteristics that concern the photomicrographer.

1) They are almost completely transparent.
2) They are quite sensitive to light of all wavelengths, and especially to radiation in the ultraviolet region of the spectrum. Their activity is more or less inhibited, depending upon the duration of exposure and the spectral emission characteristics of the light source.
3) They exhibit very reduced activity at temperatures below 30 C (86 F).
4) Their normal environment is a liquid or semi-solid one.
5) The normally prepared slide for microscopic study is very thick (8mm).
6) They respond much more satisfactorily when kept in an inverted position, therefore, the hanging drop position used for ordinary microscopic observation is not suitable for use over long periods of time.

Description of Apparatus

The apparatus consists of two separate units—a cinephotomicrographic unit and a control unit.

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Figure 1. The incubated enclosure, on top of which is seen the light source and electrical shutter. The front panel is counterweighted to provide smooth vertical operation.

Cinephotomicrographic Unit

Figure 1 shows an overall view of the cinephotomicrographic unit, with the microscope and camera housing closed. On top of this housing is mounted the light source, a 100 watt Zirconium arc, manufactured under the name *Mikrarc*.

Figure 2 is an inside view of the housing, which encloses the camera and its drive motor, the beam-splitter and focusing telescope, and the entire microscope. The microscope is inverted to accommodate the inverted slide. The housing itself is an extension of an incubator room that operates at an ambient temperature of 35 C (95 F). At this temperature no deleterious effects on the optical or mechanical components have been observed.

The camera is a 16mm *Cine Kodak Special*. It is driven through the single frame drive shaft by a 24 volt D.C. motor, 650 R.P.M. This motor, purchased as war surplus material, was modified by providing separate excitation for the field and for the armature. This modification made speed control possible.

The beam-splitter and focusing telescope arrangement was made by Leitz and, except for the absence of a shutter, is similar to the Leitz *Micro-Ibso* attachment.

All of the microscope objectives used are apochromats. The ocular is a 10X Leitz *Periplan*. The condenser, made by Leitz in years gone by, is achromatic, of high numerical aperture, centerable, and has a long working distance.

Figure 2. Within enclosure are the motor, mechanical linkage, camera, and inverted microscope.

The stage is a Spencer circular, revolving, mechanical stage, *Model*—V mounted in a normal manner.

Interposed between the condenser and the light source is an electrically operated shutter, such as is used with an enlarger having one of the older type gas discharge tube light sources. This is the shutter that makes the exposure. It is normally closed, and is controlled by an electronic timer.

The entire unit is mounted on the stand of an old *Edinger-Clark* microprojector fastened with bolts to a heavy table top. There have been no vibration difficulties from external sources, despite the fact that the apparatus is on the fourteenth floor of a building situated at a street intersection that is extremely heavily travelled. Vibration from internal sources has been eliminated by having the drive motor at rest while the exposure is being made.

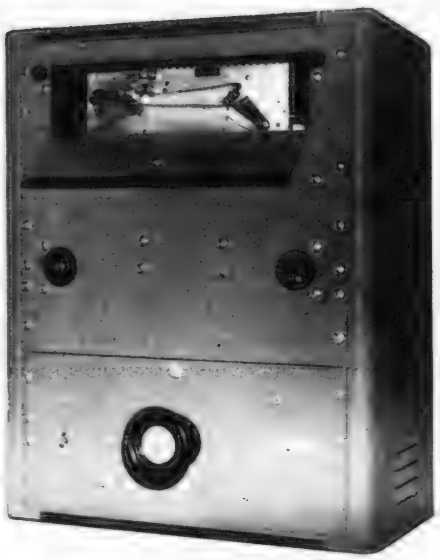

Figure 3. The control unit with the timer panel open. Hidden in this picture by the dropped panel are the two timer switches and pilot lights.

Control Unit

All the control mechanisms are housed in a separate control unit connected to the optical unit only by electrical cables. (Fig. 3). In the lower portion are the motor speed control resistors and a motor reversing switch. The center portion of the unit contains the power supply for the zirconium arc light. The top part houses the two timing mechanisms.

The main timer is driven by an electric clock type motor rotating at 1 R.P.M., directly connected to a 16mm motion picture projector sprocket. Around this and a spring loaded idler sprocket is passed an endless belt made from a length of 16mm leader stock by splicing it end to end. This belt has holes punched in it at predetermined intervals. When one of these holes passes between a pair of electrical contacts a relay is momentarily energized, and a cycle of operation started. The distances between the punched holes on the belt determine the time interval between the cycles of operation. With an original stock length of 16 inches made into a belt, the time intervals available are from 1 cycle per second to 1 cycle every 9 minutes. With longer belts, longer intervals are obtainable. The timing belts are accessible and easily changeable through a small hinged panel in the front of the control unit. The 6 volt A.C. passing through the belt contact points, even after many hours of use, produces no visible damage to the acetate base leader stock from which the belts are made.

The timer relay, when momentarily energized, actuates half of a latching relay. This closes the motor circuit allowing the motor to rotate. When the motor has made one revolution and pulled one frame of film through the camera, a small

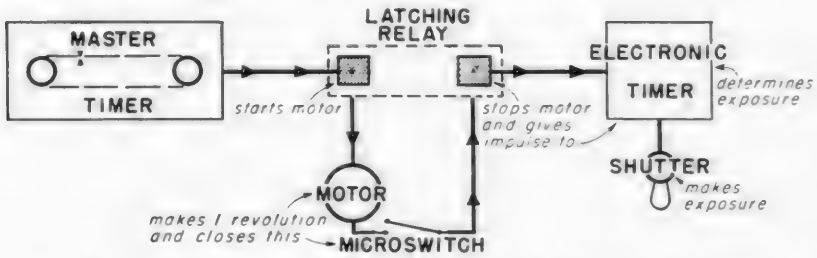

Figure 4. The cycle of operation illustrated diagrammatically.

pin on the drive shaft momentarily closes a microswitch. This energizes the other half of the latching relay, the function of which is to open the motor circuit. At the same time another relay is energized that actuates the electronic timer (Fig. 4).

The electronic timer is a conventional circuit with a time range of from ½ second to ten seconds. This timer actuates the exposure shutter.

The camera drive is so arranged that when it comes to rest, the camera shutter is open. The cycle of operation will not be completed if the pin on the motor drive shaft stops at dead center, keeping the microswitch closed. Therefore, the motor speed is adjusted so that the pin slightly overrides the microswitch before it stops. A warning light is provided on the control panel to warn the operator of stoppage at dead center.

Technique

The microscopy technique used is beyond the scope of this paper. First class optics are essential, and like any other photomicrography, an expert microscopist must be in command of the situation to produce optimal results.

Unfiltered light from the zirconium arc lamp is never permitted to reach the slide. For focusing, a Wratten K-2 yellow filter effectively removes the harmful ultraviolet. For exposure, a Wratten C-49, deep blue filter is used. Exposures have generally been in the neighborhood of one second.

Since a slow, high contrast film was desired, Eastman Kodak *Fine Grain Positive* was chosen. One of the most desirable features of this type of film, is its ease of handling under a *Series OA* safelight.

Development in D-11 was done by inspection rather than by time-temperature. This is feasible when using the Morse G3 developing tank, since the tank has a small window.

Film is evaluated and edited on a war surplus Naval Ordnance "gun camera" scoring viewer which, with its reticules and start-stop-reverse control, is an ideal instrument for the purpose.

Acknowledgments

The construction of this apparatus was made possible by funds provided by the *Committee on Growth* of the The American Cancer Society.

Thanks also are due the staff of the electronics shop of the Department of Neurology for invaluable technical advice, and to the department itself, with which the author was associated for much of the time that the apparatus was under construction. I should like especially to express my gratitude to Dr. Margaret Murray of this department for clarifying the biological problems, and for a wealth of information on techniques of microscopy.

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Medical Illustration and Psychiatry*

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Introduction

THIS report of a medical illustration laboratory in a psychiatric program is based upon six years experience at Winter VA Hospital, Topeka, Kansas. The purpose of the report is to explain the kind of contribution which medical illustration may profitably attempt in that large field of medicine where its use has been least extensive and where its development requires a new approach and new methods. The VA Hospital at Topeka, though general, is predominantly neuropsychiatric. The staff is responsible for the treatment of 1,000 patients on the Neuropsychiatric Service, for the education of large numbers of psychiatric residents and other professional personnel, and for a continuous program of psychiatric and neurological research. To show the influence of this institutional setting upon the organization and the function of the Medical Illustration Laboratory is the objective of this paper.

Psychiatric Medicine As A New Field For Medical Illustration

Brief reflection upon the background of the mental health movement will help the reader to understand the special problems and the challenge for medical illustration in a psychiatric institution. Psychiatry is now fully accepted as a medical science in the sense that pediatrics or surgery is a medical science. Hundreds of physicians each year begin the three-year program which will qualify them for psychiatric practice. Half of the hospital beds available in the United States are occupied by the mentally ill. Surveys indicate, furthermore, that 30% of hospital cases classified as general medical and surgical require psychiatric attention, and that perhaps a majority of those patients who consult the general practitioner suffer from "functional" rather than organic disorders[1]. In spite of inadequate funds for treatment and an inadequate number of trained personnel, from 50 to 75% of hospitalized mental patients recover or improve sufficiently to return home. It is the conviction of those in the mental health movement that with increased knowledge and a larger number of professionally trained people, psychiatrists, clinical psychologists, psychiatric nurses, social workers, and adjunctive therapists, the flow of mentally ill patients into hospitals can be reduced and the chances for recovery of the hospitalized may be increased.

The contributions of the medical illustrator to psychiatry are conveniently divided into two kinds. In the mental health movement, the first step is to inform the public in order to win understanding and support of psychiatric study and treatment. Everything from comic books to motion picture films has been produced in this large campaign of propa-

* Received for publication, April 6, 1953.

ganda. The Canadian Film Board series of films demonstrating mental mechanisms, the New York Mental Hygiene Blondie comic books, and the National Mental Health Foundation's Tenth Man Series of recordings are a few of the outstanding examples.

In the second place, the medical illustrator contributes on the professional level to psychiatric research and treatment and to psychiatric education. Psychiatrists and psychologists are familiar with the use of audio-visual aids. Over five hundred films on mental health are available to colleges and clinical centers for teaching purposes. Promising experimentation has been done with the use of films for diagnostic and therapeutic purposes.*

The extensive and versatile use of sound recording in this field of medicine, which depends so much upon "talking therapy", has been stimulated by the economy of embossing and magnetic sound recording. Abstract, symbolic designs are the artistic productions which are most commonly used by the psychiatric author and lecturer for graphic illustration (Figure 1).

In spite of a good deal of use of medical illustration in psychiatry, both popular and scientific, it is still true that medical illustration has not found its place, is not taken for granted and used as a matter of course, in psychiatry as it is in longer established medical specialties, such as pathology or surgery. At the present stage of psychiatric methods in research, education, and clinical practice, the medical illustrator may best function if he disciplines himself to be

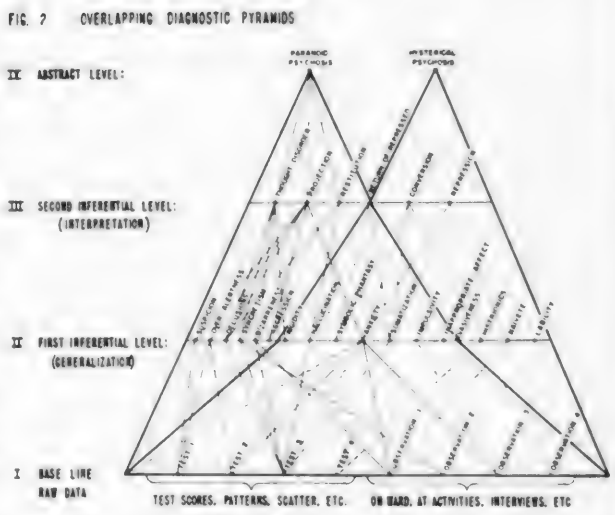
FIG. 7 OVERLAPPING DIAGNOSTIC PYRAMIDS
IV ABSTRACT LEVEL:
III SECOND INFERENTIAL LEVEL: (INTERPRETATION)
II FIRST INFERENTIAL LEVEL: (GENERALIZATION)
I BASE LINE RAW DATA
TEST SCORES, PATTERNS, SCATTER, ETC.
OBSERVATIONS OF BEHAVIOR, ACTIVITIES, INTERVIEWS, ETC
Figure 1

recognized as an expert in communication. By studying with the psychologist and the psychiatrist the opportunity in this field for better communication by audio-visual aids, the medical illustrator may be of greater service than if he confines his attention to problems of technology and craftsmanship.

The Function and Structure of the Medical Illustration Laboratory in the Psychiatric Program

At the VA Hospital of Topeka, the Medical Illustration Laboratory has progressed from a staff of one to a staff of four and from a small room attached to the office of the Director of Professional Education to a separate building, equipped for making sound films and other types of sound recordings, with a complete photographic laboratory. Adequate space and equipment are provided for artistic productions ranging from large models to charts and graphs. As the final section of this paper will show, the

* Mental Health films are available from most film libraries. Listings of a number of films can be obtained from: (1) New York University Film Library, 26 Washington Place, New York 3, N.Y., (2) Psychological Cinema Register, Audio-Visual Aids Library, Pennsylvania State College, State College, Pa., (3) Federal Security Agency, Public Health Service, National Institute of Mental Health, Washington 25, D.C.

staff of the laboratory maintains a busy as well as a varied program, which includes the circulation and operation of audio-visual aids as well as their production.

The present demand for the services of the laboratory is the result of a gradually developing association between the Chief of the Laboratory and many members of the professional staff of the Neuropsychiatric Service. The principle on which this association has developed is that medical illustration must respond imaginatively to the fundamental objectives of its institution. Psychiatric practice, education, and research are the objectives with which the Laboratory being described must be concerned. The Chief Illustrator has encouraged members of the staff to form committees with him from time to time for the study of communication needs in one area of professional interest or another, in order that he might suggest to the professional staff member audio-visual techniques or combinations of techniques which might meet the need. The Chief of the Laboratory keeps himself familiar with the circumstances and general methods of communication, such as staff conferences, panel discussions of patients or staff, and demonstrations in a one-way vision room, which are used throughout the hospital. As general methods develop and change, he plans with the professional staff the adaptation to new purposes of the basic audio-visual techniques.

A second consideration is so important from an administrative point of view that, although when mentioned it may appear obvious, it should not be overlooked. As an administrative person responsible for planning and organizing as well as for good craftsmanship, the Chief of the Laboratory has found that

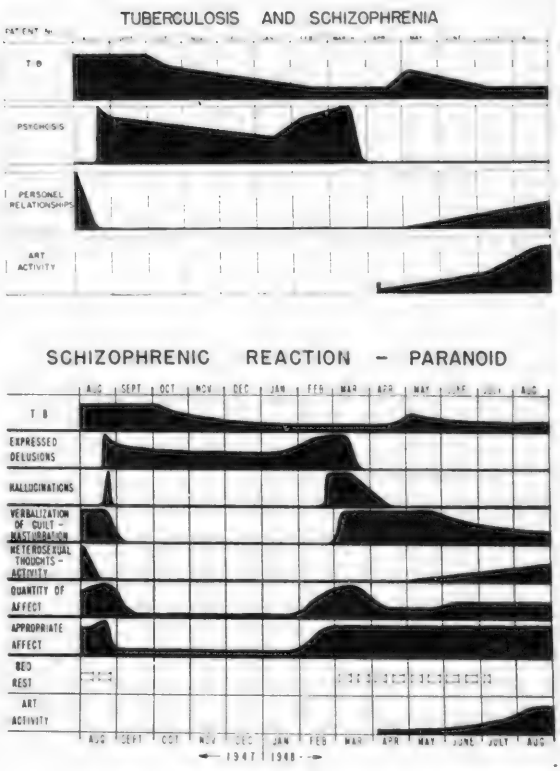

Figure 2

it is indispensable for him to strive for a shrewd and accurate knowledge of the hospital's structure and operation. Sufficient to say that the formal table of organization with its theoretical lines of communication and its theoretical division of responsibility does not reveal which persons are influential, which persons have the initiative, or which persons one must see and come to an agreement with if one wishes to get something done. With each new appointment to an important professional position, the operating structure of the hospital changes; the planning and realization of new projects must be accomplished differently.

The laboratory of the Topeka VA Hospital provides audio-visual material by three methods:

1) By circulating from a stock of slides, models, films, and recordings accumulated in the laboratory. All of this material is cross-indexed and available on a check-out basis at all times.
2) By borrowing from various sources. The laboratory keeps an up-to-date supply of catalogues and other types of notices on audio-visual materials available by loan or by purchase.
3) By production. Approximately one-half of the energy of the laboratory staff goes into production by art, photography, sound recording, and combinations thereof.

Equipment required for the use of audio-visual material is centralized at the laboratory. The equipment consists of 16mm motion picture projectors, slide, and opaque projectors, sound reproduction equipment and projection screens. In addition the laboratory is responsible for x-ray view boxes and microscopes used in lecture rooms, blackboards (which is still the most widely used visual teaching tool), black-out screens, and public address systems when used in teaching. Although all of this equipment flows through the Medical Illustration Laboratory, the illustrator does not take the responsibility of operation. Regular users of audio-visual material are instructed in the operation of the equipment, and they check out slides, recordings, films, projectors, and record players.

By the professional consumer, a one-stop service for audio-visual material is much appreciated. The illustrator, on the other hand, can see his work through to its logical conclusion—the place where it is used. This perspective, which enables him to keep informed of all activity and interest in his specialty, is the best insurance he can have for continued good relationship with the staff. The most common criticisms of audio-visual material

Figure 3a

are not directed at the work of the illustrator, but have to do with inability to get a projector when and where needed or failure of the equipment to function properly when it is on hand. It is well to remember that a projector which does not function properly can cancel off many hours of work over the drawing board and in the dark room.

The personnel requirements of the laboratory are determined by the need for specific skills and the volume of work. For the past two years, the laboratory has operated with four persons: artist, photographer, sound engineer and clerk typist. Each person is familiar with the total operation of the laboratory and is trained for more than one kind of laboratory work. It is not unusual to find the photographer at a drawing board, the sound engineer and clerk typist in the dark room, and the artist running a projector. Naturally the more difficult assignment is handled by the one most capable and skilled in the job. The elimination of a restrictive work area for each individual in the laboratory has eliminated unproductive competition among the staff. The photographer does not feel that he must dominate the artist, but rather the staff unites in competition with the job of illustration at hand.

Examples of Production

The productions of the laboratory are accomplished by techniques of sound recording, photography, and art. Though many of our requests for production are of a kind to be expected in a general hospital, most of our requests come from the neuropsychiatric program, and these require originality, as the examples which follow will demonstrate. During the past five years 1,550 drawings have been produced, no more than 25 of which are anatomical. Figures 1 and 2 represent

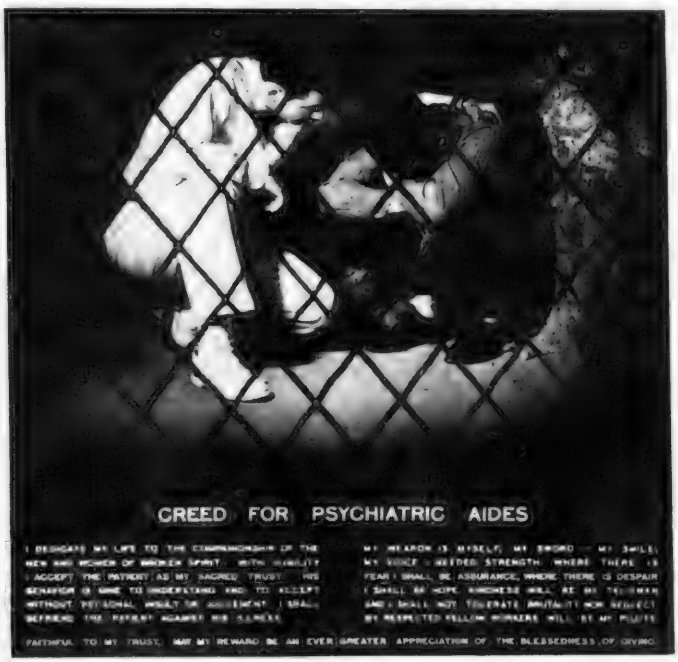

Figure 3b

the art production. In Figure 1, the diagram represents a process of arriving at different psychiatric diagnoses by different kinds of observations. In Figure 2, the two charts show relationships of physical and mental symptoms in complex illnesses. These charts were reproduced as slides and used at a clinical conference as a means of illustrating and summarizing the findings of a clinical team.

The sound recording equipment of the laboratory consists of four recorders of the embossed disc type, five magnetic wire recorders, and one machine for cutting permanent discs. The embossed disc machine is used when an inexpensive permanent record is desired, for which the play back quality is not important. It is used to record, for example, interviews conducted behind one-way vision screens. The recordings are used mainly during the discussion immediately following the interview as a support to the memory of the participants and listeners.

Flexibility is the chief value of magnetic recording. The equipment is easy to move about and simple to operate. The wire (or tape) can be used indefinitely, or the recording can be transferred to discs and filed. Selected parts of group therapy sessions, psychiatric interviews, and lectures are preserved in this way. Because of this flexibility, magnetic recorders are extensively used. A good example is their use in an extensive project of group psychotherapy which has a research objective as well as an immediate clinical purpose. The significant therapeutic method of the project consists of the assignment of four to six patients, from each ward group of twenty-five participating, to membership on a panel. The ward physician serving as moderator, the members of the panel discuss the merits of requests which come to them from patients within the group and before an audience of all patients of the group who are not on the panel. The requests considered pertain to the reassignment of patients to wards which provide less security and which are on the road toward discharge from the hospital. This therapeutic method serves to focus intensively the attention of the patient requesting a change upon his own problems, and it also motivates other members of the group to attempt the same kind of coming to grips with the problem of their tenure in the hospital. On a controlled basis, some ward groups thus organized have used magnetic recorders. These groups before each panel discussion listen to the recordings of the immediately preceding meetings. The consensus of the staff is that the use of the recordings accelerates the conduct of business by the panels.

Medical illustration makes original contributions to the neuropsychiatric program by still photography both in the teaching of neurology and in the in-service education of hospital personnel on the effect of employee attitudes in the care and treatment of patients. For the neurological instruction, extensive sets of slides have been produced on neuroanatomy, clinical neurology, and neuropathology. Skull x-rays and photographs of brain specimens are characteristic subjects. Figs. 3 a and b exemplify the photography used in the in-service education of the hospital employee. The psychiatric staff attempts to inform each employee of his need to maintain therapeutically beneficial attitudes toward the patients with whom he is associated. In every photograph which will permit this emphasis, the laboratory staff attempts to bring it out.

Motion picture film is produced routinely in the laboratory for use in psychological testing, for the recording of

psychological test results, and as a means of reporting by research workers. At the time this paper was written, three special projects of motion picture filming were under way. Of two projects, the objective was four-minute illustrative films. One of these projects is aimed at a series of sound films representing classical psychiatric syndromes, which will require several years to complete. Each film shows the characteristic demeanor of a selected patient. Since each one lends itself to either generalized or detailed exposition, it may be used in situations as different as a class for the orientation of newly employed aides and a seminar for residents in psychiatry. As experience with psychiatric education in the hospital accumulates, illustrative films appear to be useful in different areas of knowledge.

The composition of a series of films is also in progress for special use in the in-service training of psychiatric aides. Planned as brief illustrations to accompany classroom lectures and demonstrations, these films deal with such subjects as keys, silverware, mail, and restricted items. They average about 200 feet in length. Their sound content includes both actor dialogue and narration.

The objective of the third project is to educate personnel of a continued treatment service in the rehabilitation of patients after lobotomies. This film is designed to show the behavior of a characteristic patient before lobotomy and his behavior after the operation as conditioned by various rehabilitation methods.

Contributions to the laboratory often represent a combination of methods as the following example shows: A psychologist had the problem of investigating evidence among schizophrenic patients of thinking based upon a literal perception of phenomena as distinguished from fantasies of the supernatural. The psychologist read of one investigator who had filmed the use of the rotating trapezoid and of other investigators who had produced a film for psychological testing. The laboratory obtained both of these films for the study of the local psychologist, and then, when he decided that he could use the methods of the other investigators, arranged to duplicate the film on testing and to purchase the rotating trapezoid. For this research project, the laboratory staff set up a testing room, provided a motion picture projector and a screen, and made sound recordings of the patients tested. Part of the test material was made in the laboratory, consisting of a film of thirteen sequences, showing two color rectangles moving at varying speeds and with different types of action. On completion of the research, the laboratory made photographs of the testing room with its equipment and drawings from the photographs to submit with a manuscript for publication.

Summary

Psychiatry, which in number of patients is the largest area of medicine, requires audio-visual aids in treatment, education, and research. This demand presents a new field for development to the medical illustrator. He must take the initiative by learning the needs of the psychiatrist and by making available both his craftsmanship and his creative skill in audio-visual communication.

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Cinematography of the Human Eardrum*

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PHOTOGRAPHY of the eardrum is not new but it has been neglected. All phases of the problem have been recognized and some practical solutions have been offered in the past. Unfortunately, previous methods consisted mostly in developing a complicated and expensive new instrumentarium. Due to the extraordinary expenses and the unavailability of these special cameras, eardrum photography has not been taken up by biological photographers generally. The result, therefore, is that today we do not have any routine eardrum photography.

Adapting Standard Equipment

In planning our method of eardrum cinematography, the attempt was made to utilize only standard apparatus which is found in every well equipped photographic department of a hospital. No financial obstacles can stand in the way for this "austerity type" of eardrum cinematography. The needed equipment items are,

1) Any camera permitting focussing without parallax. We employed the *Kodak 16mm Cine Special.*
2) The usual range of 16mm camera lenses. A 6 in. lens proved satisfactory for most eardrum work.
3) A head mirror as used by the otologist. A concave mirror of about 6 diopters, with a perforation in the center.
4) A 2 in. x 2 in. slide projector as a light source.
5) An optical bench.
6) Standard metal bars and clamps.

In addition to these ordinary items, it is necessary to have a machine shop make a holder for placing the camera onto the optical bench. Similarly, a holder for the lenses and the mirror is necessary.

No special equipment for immobilizing the head is used. The patients are placed in the examining chair and the headrest is adjusted. The whole apparatus is on a portable table (Fig. 1). The light source (A) is high and adjusted so that the light beam falls on the mirror (B) which is positioned such that the reflected light is coaxial with the camera axis.

For our work a small Kodak 2 in. x 2 in. projector with a 300 watt lamp is used as the light source. Heat absorbing glass is attached to the system of condensing lenses. The lamp has a suitable color temperature for color photography when operated at its rated voltage, although color correction filters may be necessary under some circumstances. The light

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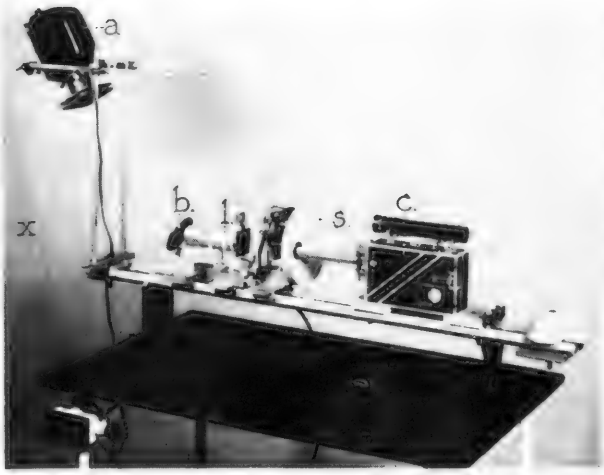

Figure 1. The photographic set-up for eardrum photography. Various magnifications can be obtained by changing the distance between L and C. See text for further description.

beam is focussed onto the concave mirror. The mirorr stands at an angle of about 30-40° and deflects the light back toward the patient into the ear canal. With this arrangement one obtains a concentrated, brilliant light beam, which in spite of its intensity is not too hot to be tolerated by the eardrum. The camera image is focussed through the hole in the mirror. This gives the coaxial arrangement of the light with the camera axis.

Anatomical Considerations

The eardrum is a membrane, 1/10 mm thick (Fig. 2A). Due to its thinness, certain structures in the middle ear shine through the membrane, without being completely sharp. The area of the eardrum is about 90 square millimeters (Fig. 2B). The drum membrane is located at the end of a winding canal. The diameter of the canal varies individually from a one centimeter round lumen to a slit-like lumen of only 3 or 4 mm in diameter. Some canals are straight. In most cases, however, the meatus has a winding course. The procedure for eardrum photography is identical with clinical otoscopic technic. In order to straighten the ear canal, one pulls on the auricle. An upward and backward movement straightens the canal in most cases satisfactorily. Hair growth of various density, length and thickness represents an obstacle for the photographer. It is overcome by insertion of an ear speculum, which bends the hair sideways. Optical reflections on the shaft of the hair produce a Tyndall effect and is a much greater nuisance for the photographer than for the clinician during otoscopy. Various methods to fasten and to immobilize the speculum have been tried. Rigid fastening of the speculum, however, is not imperative. On the contrary, slight motions of the speculum are carried out purposely during the exposure to expose all parts of the eardrum.

The length of the ear canal is about 25 mm. The depth of field is only 2 to 3 mm in intact eardrums. In cases of eardrum perforation with exposure of the medial tympanic wall, the depth of field is 4 to 6 mm. The working distance varies, of course, with the magnifications used. An average distance of 20 to 25 cm is sufficient to admit the light into the ear canal and to obtain good magnification.

The Arrangement of the Lenses on the Optical Bench

The separation of the lens from the camera makes it possible to move the lens freely on the optical bench and thereby change the distance between lens and film emulsion. Different enlargements are thereby obtained. The 6 in. lens was used routinely for eardrum photography. This permits object to image ratios up to 1 to 3. Considering the possibilities of enlargement it may be appropriate to borrow a term from the oculist. One may call the

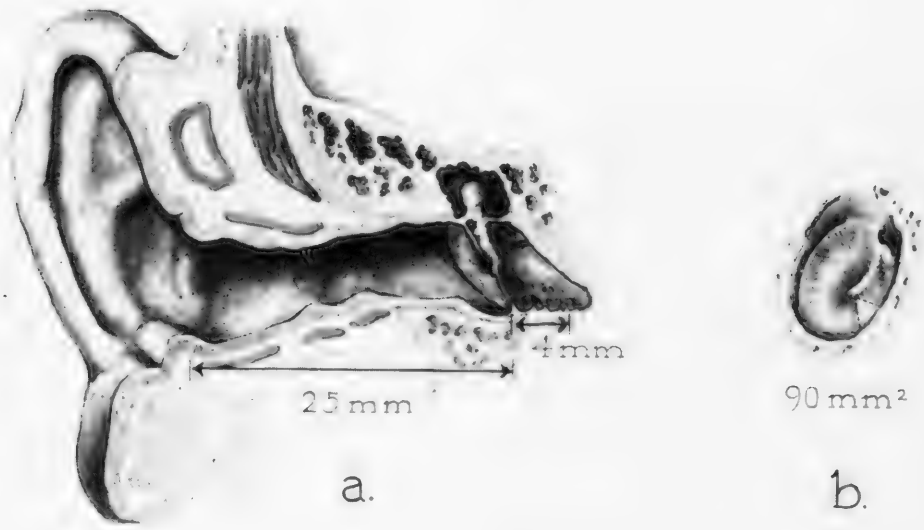

Figure 2 (A and B). A schematic view of the outer ear canal, eardrum, and middle ear is shown in (A). The eardrum is located at the end of a winding, narrow canal. Hair located at the entrance is bent aside by the ear speculum. (B) shows a schematic view of the eardrum. The drum membrane is oval in shape, and approximately 10mm in diameter. The triangular reflex, outlined by the dotted line, stands vertical to the axis of the light. Therefore, it reflects light more than the rest of the eardrum area.

enlarged photographic recording a *biomicroscopy* of the eardrum. It is possible to see details on the projected picture which the otologist cannot visualize by routine otoscopic examination.

The focussing and framing of the picture is done in two steps. Gross focussing is accomplished by positioning the head of the patient. Turning and tilting of the head brings the axis of the ear canal into coaxial alignment with the camera axis. Finer focussing and framing is accomplished by the adjustments on the lens holder (Fig. 3). Up and down movement of the lens make it possible to center the image properly in the vertical axis. Side movements of the optical bench align the eardrum for centering in the horizontal axis.

Color Rendition

Unfortunately, most otologists have the habit of examining their patients with artificial light sources which have a too yellow hue. Therefore, color photographs obtained with color corrected light may appear strange to the otologist unless viewed under a yellowish light. Other problems inherent to color photography make universally acceptable color rendition a difficult achievement. It is advisable to use emulsions which are especially made for duplication purposes. Prints made from these originals have a more normal contrast and color rendition than prints made from color films intended for direct projection. If planned, however, to project the original, a color film balanced for tungsten light should be used.

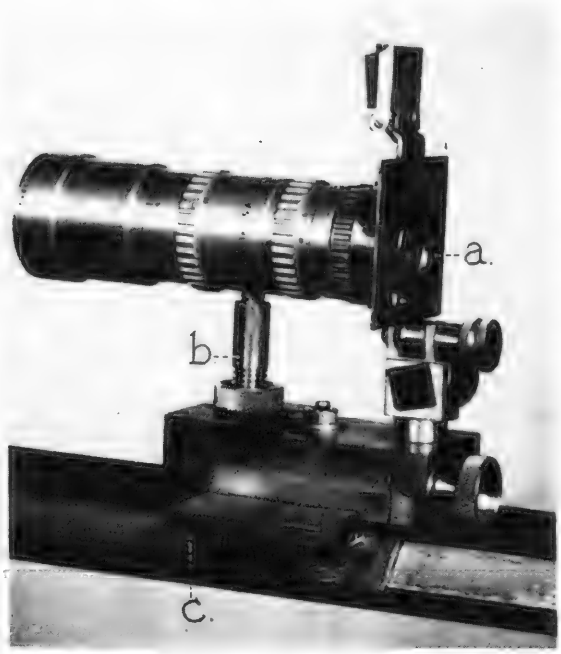

Figure 3. Lens holder designed by Mr. J. Whitman. A commercial lens adapter is located at "a". Fine vertical adjustment at "b" permits proper image framing. A brass holder slides on the optical bench "c" for changing film-lens distance.

Advantages of Motion Pictures

Now the question: Why cinematography and not still pictures of the eardrum? We were guided in this decision by the nature of eardrum examination. The ear specialist when examining a patient cannot in most instances see all parts of the eardrum at the same time. Knowingly, or perhaps unknowingly, he executes small motions of the ear speculum and thus brings the various areas of the eardrum into view. Therefore the routine examination of the human eardrum is a dynamic process, and it was felt that only a motion picture would simulate clinical otoscopy. Modern projection equipment makes it possible to arrest the motion of the film, so that whenever desirable a single frame can be projected with the same advantages as a still picture. Furthermore, it is possible to make slides from single frames of the 16 mm motion picture.

Additional advantage in taking movies rather than still pictures lies in the fact that several dynamic phenomena occur in the ear which still photography cannot record. For example, respiratory movements of the eardrum, while not normally visible, are seen under certain pathological conditions. Pulsation of pus in infections, the contractions of the stapedius muscle in properly selected cases and the acoustic oscillations during auditory stimulation are important dynamic phenomena which only the motion picture can record[1].

The advantages of eardrum motion picture photography for undergraduate and postgraduate training are obvious. The process of acquiring the necessary skill to master the technique is a slow and painful one for the student. The help for the student by seeing in a motion picture selected otoscopic findings is considerable.

For the graduate student there are many advantages also. In large groups, the demonstration of an ear patient is not possible because the members of the audience could not possibly all carry out an otoscopic examination. The projection of a motion picture recording permits the whole audience to assess the clinical otoscopic findings.

For the clinician, the cinematographic recordings of otoscopic findings represent a possibility to keep a record for later re-evaluation. Findings before and after surgery, increase or decrease of a perforation in a chronic otitis media, or the placing of an artificial eardrum, can be made a matter of permanent record.

REFERENCE

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Stereoscopic Photography of Biological Specimens With an Ordinary Camera*

VALENTINE J. CONNOLLY, B.S.

Introduction

The ultimate aim of medical and biological photography is to reproduce an image of the specimen as accurately as possible. Modern color film emulsions approach this ultimate, but because of physical limitations the usual transparencies lack the perception of depth necessary to complete the impression of reality. It would seem to be worthwhile to elaborate a procedure whereby the dimension of depth can be obtained to complete the tri-dimensional illusion of reality in the illustration and demonstration of medical and biological specimen material. That this aspect of photographic presentation is in its infancy is indicated by the fact that Kline and Stevenson[1], in a recent review of the application of photography in the field of medicine, listed ten different types of photographic procedures in use today, but they did not include the stereoscopic technique. The recent development of *Cinerama*, *Tri-Opticon* and *Natural Vision* motion picture photography, all of which are systems to give illusion of perception as the human eye sees it, further indicates that the modern trend is toward this type of photographic presentation. The purpose of this communication is to describe the technique and equipment necessary to produce stereoscopic photographs of specimen material without the need of a special stereo camera.

* Received for publication February 20, 1953.

Principle

The procedure applies the principle that accurate stereoscopic reproduction can be achieved when two images of the same object can be obtained from two different angles comparable to the normal human visual interocular distance. The theoretical basis is well elaborated by Verhoeff[2]. Photographically this is normally accomplished by the use of a special stereo camera equipped with two lenses set at specified distances. It is known that if a single lens camera could be moved the necessary distance, stereoscopic images should result. However, in

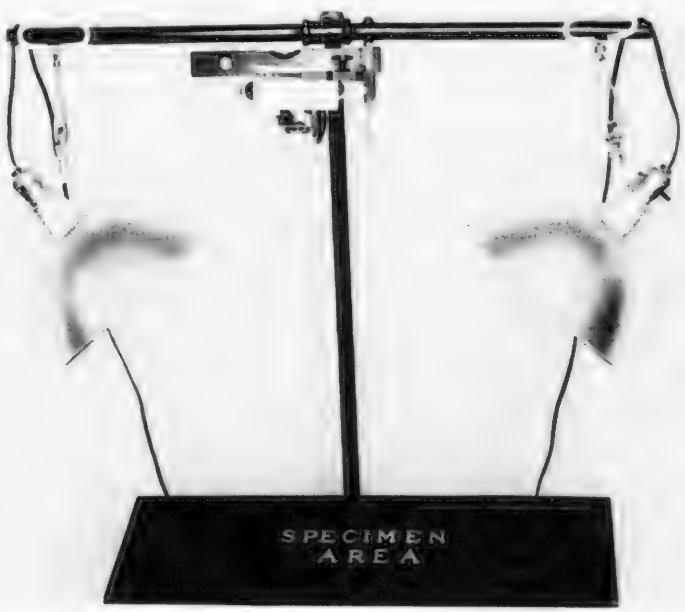

Figure 1. Apparatus ready for use.

photography of medical and biological specimens variables enter which must be controlled. For example, it is desirable that the specimen be closer to the lens of the camera than the working distance allowed by the focal length of the commonly used lenses. Visually the eye makes this adjustment by convergence, "toeing in". Technically this can be achieved with the camera only by the addition of accessory prisms and lenses or by varying the interocular distance used in photographing the specimen.

Equipment

The equipment shown in Figure (1) consists of an ordinary inexpensive *Planar* camera, 35mm size, attached to a solid metal frame. The two No. 2 photoflood lamps are so fixed that they evenly illuminate the specimen area. The lens is an f/3.5, 50mm focal length. An f/4.5 lens would be as satisfactory, and a short focal length more desirable. The one essential is that the camera have a 1 second exposure shutter speed. The close working distance demanded by the setup requires the utilization of the smallest lens aperture available to obtain as great a depth of field as possible. An inflexible rule of stereo technique is that everything in the picture must be in sharp focus. A *Voigtlander Focar No. 1* supplementary lens is used to decrease the effective working distance to more fully utilize the film area and to increase the size of the film image of smaller specimens.

Figure (2) illustrates the mechanism necessary to reproduce duplicate images that will be in stereo relationship. It is a refinement of the slide bar commercially available for this purpose*. The camera is attached to a vernier millimeter scale so that it can be moved to obtain desired interocular distances. In addition, a level must be used to determine that the film surface is vertically and horizontally parallel to the specimen area. If the plane and parallel relationships between the film and specimen are maintained when the camera position is shifted, excellent stereoscopic reproduction is achieved.

A distance of less than two feet for the specimen to camera is too close for good stereo viewing. This is important because it is generally accepted that objects observed at such a close distance cause great discomfort when viewed in stereo. Therefore, a mechanical interocular adjustment of the camera lens is made to have the specimen appear to be farther away when viewed in stereoscopic vision. The desired interocular distance must be calculated on the basis of the actual specimen distance from the camera lens and the apparent distance at which one wishes the specimen to appear to be when viewed in the stereoscope. To compute the interocular distance necessary to accomplish this effect one may use the following simple proportion

* Adapted from a medical microscope mechanical stage

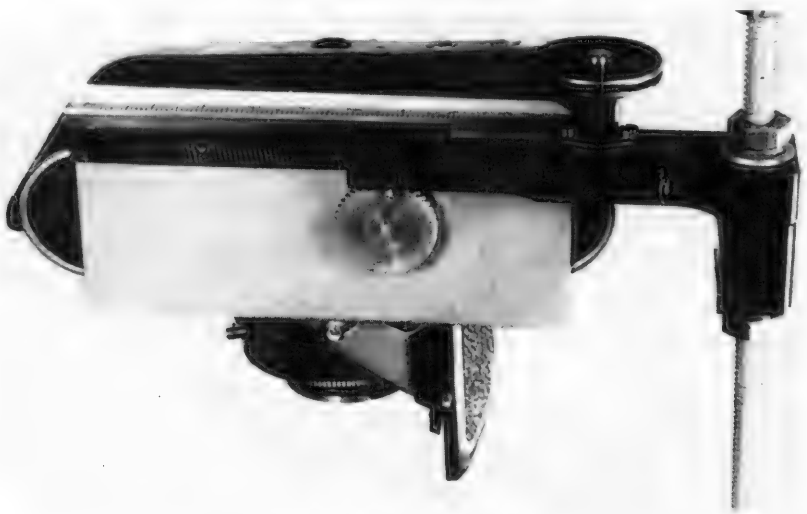

Figure 2. Camera showing vernier scale mechanism.

where AD would be the apparent distance taken as four feet, TD would be the true specimen distance, NI would be the normal visual interocular distance and X the required reduced base. All measurements are stated in millimeters.

$$AD/TD = NI/X$$
$$1200/600 = 65/X$$

Thus, we obtain an interocular distance of 32.5 millimeters. The author uses a distance of 32 millimeters.

Calibration Procedure

The calibration of the setup is similar to that previously described for ordinary color photography[3,4]. The back of the camera is opened and a piece of ground glass is placed at the film plane. The portrait lens is attached and a millimeter ruler is placed in the specimen area raised on a block of wood so that the ruler will be approximately 21 inches from the camera lens. This allows for the height of specimens raised from the platform plane. With the lens wide open a critically sharp focus is obtained of the millimeter divisions observed on the ground glass with the aid of a magnifying glass. Once this setting has been located it must not be disturbed by jarring. Indoor color film is inserted and an average specimen placed on the apparatus. The lens opening should be closed to the smallest stop available and an exposure of one second used. The frame is moved along and another exposure made with the next shutter speed. This procedure is repeated until a series of exposures using combinations of shutter speeds and lens openings have been taken. After the film has been processed the best combination can be determined for future use. We have found that a one second exposure at f/16 with two No. 2 photoflood lamps placed 16 inches from the specimen gives excellent results.

Making the Stereograms

Once the setup has been calibrated stereograms can be made by placing the specimen in the center of the field and making the first exposure. The camera is then moved 32 millimeters using the vernier millimeter scale as an indicator of distance and a second exposure of the specimen made from the different angle. When properly mounted these two images will be in stereoscopic relationship. If the apparatus is not disturbed subsequent stereo pictures can be obtained by merely placing the specimen in the area and making the two exposures as described above. All light readings, focusing, adjusting, etc. are completely eliminated.

When the developed films have been received they must be mounted in special stereo mounts. We have found the *Sterling Verascope Cardboard Quick Mounts* inexpensive and satisfactory. These are readily available from photographic dealers. The essential of good mounting is to cut the two images and place them in the mounts in such a manner that homologous points on each image are exactingly parallel horizontally and vertically. In addition identical points must be positioned approximately 63.5 millimeters apart for the procedure described. The proper alignment can be achieved with a little practice but it must be emphasized that the mounting procedure is critical for excellent results. The finished product can be viewed in the inexpensive hand stereoscopic viewers that cost less than ten dollars. Should projection be the method of choice, an adjustment of the calculation of the stereo base can be made which, by reducing the interocular shift, results in better stereograms for projection purposes. Detailed instructions can be found in technical publications on the subject[5].

Summary

A procedure is described for constructing and calibrating an apparatus to obtain stereoscopic photographs of medical and biological specimen material. An ordinary single lens camera is used, eliminating the need for the special two lens stereo camera. The same apparatus may be used for taking ordinary single color photographs.

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Photography in Medicine and Surgery

FRANK SMITH

(A brief report on the photographic aspects of the Technical Exposition at the 102nd Annual Meeting of the American Medical Association, New York City, June 1-5, 1953.)

ONE of the outstanding features of the 1953 A.M.A. Technical Exposition was the display of photographs, both black and white and color, used in connection with the hundreds of scientific exhibits. The photographs represented some of the finest examples of medical and surgical photography extant. They vividly illustrated the results obtainable by application of modern techniques and photographic instrumentation.

A brief survey of some of the specialized photographic instruments exhibited follows:

Coreco Research Corp., 1908 Broadway, New York, N.Y., makers of the *Coreco* "300" *Automatic Color Camera*, presented their new "*Coreco-Flash*" clinical camera, a new, low-priced ($487.00) addition to the Coreco family of automatic cameras.

Fairchild Camera and Instrument Corp., Syosset, L.I., N.Y. exhibited several series of diagnostic radiographs on roll film exposed during the passage of an X-ray-opaque material through the blood vessels of the body. The exhibit also highlighted the roll-film cassette in which the film was exposed; the equipment for processing; and the Fairchild 70mm cameras and accessory equipment.

Gastro-Photor Laboratories Corp., 17 E. 42nd Street, New York 17, New York, displayed and demonstrated their new *Gastro-Photor Camera* which has sufficient light and speed (50,000 candlepower for 1/500th of a second), to arrest peristaltic action. The camera, which is placed directly into the orificial cavity, takes in one operation sixteen photographs of the circumference of the stomach, or of the sigmoid, cervix, throat, or pelvis. Since the camera photographs the entire cavity, it is not necessary to select any one spot; but if desired, a fluoroscope may be used to localize the camera.

Another highlight of the photographic instrumentation exhibit was the newly developed *35mm Bucky Color Camera* (U. S. Pat. No. 2,638,039) invented by Dr. Gustav Bucky and designed especially for the medical professional. The camera is marketed by the International Medical Research Co., 60 E. 42nd Street, New York City and is claimed to possess many features not available in other cameras. Among these may be mentioned, the discharge-tube light source, focused exposure light, cavity viewing light, absence of mechanical adjustments, light weight, one-hand operation, and adaptability to almost any need.

The Picker X-Ray Corp., 25 South Broadway, White Plains, N.Y. demonstrated their new 60-second *Polaroid-Land radiographic process*, termed the *Picker-Polaroid Processing Unit*. The principal feature of this equipment is the complete production, in one-minute, of an X-ray picture without the use of conventional photographic developing, fixing and washing.

The Times Facsimile Corp., 540 West 58th Street, New York, N.Y. demonstrated X-ray films being transmitted over telephone circuits. This system of X-ray transmission by the *Telegnosis* process has been in use by Dr. J. Gershon-Cohen of Philadelphia for several years. The machine exhibited will be put into production within the next few months.

Another display which attracted considerable attention was the X-ray image amplifier tube of the North American Philips Co., Inc., 750 S. Fulton Avenue, Mt. Vernon, N.Y. A development of the Philips Laboratories, Eindhoven, Holland, the new device makes fluoroscopic images 800-1200 times brighter than those obtained with the conventional fluoroscope.

Walden Industries, Inc., 350 W. 50th., New York 19, N.Y. demonstrated the *Walco* completely automatic close-up photographic unit. The unit, designed especially for the professional man and industrial research engineer, consists essentially of a camera, stand, and two tungsten lamps, together with various prefocused gauges or applicators. Each gauge or applicator automatically sets the camera at the proper distance from the object to be photographed. The unit can be used with several of the various 35mm cameras now available.

The new *Retinal Camera* of the Bausch and Lomb Co., Rochester, N.Y. was demonstrated. This camera is designed for photography of the fundus, and is quite similar to the well-known *Zeiss-Nordensen Retinal Camera*.

The Society of Photographic Engineers*

EDWARD K. KAPRELIAN
Past President

(This is the third in a series of invited papers on leading photographic organizations.)

THE Society of Photographic Engineers was organized in January 1947 in Washington, D.C. with Raymond Davis of the National Bureau of Standards as its first president. The following year it incorporated as a national organization under the laws of the District of Columbia.

Its objectives are stated in the Society Constitution:

> "The purpose of this membership corporation shall be the advancement and diffusion of knowledge of the science of photography and its applications. Its objectives shall include: (a) The publication of a scientific journal devoted to photography and related sciences; (b) Serving the public by making available to journals, newspapers and other media reliable communications relating to photographic engineering and its progress; (c) Cooperation with local, national and international organizations devoted to photography through research, by application of its principles to scientific ends, by teaching and by study; (d) Furthering the application of science, engineering and industry."

The administration of the Society is vested in a National Board of Directors comprising the President, Executive Vice President, Engineering Vice President, Editorial Vice President and a Financial Vice President, together with a number of Directors elected by the various chapters in accordance with the size of their membership. A number of members in any locality may unite to form a chapter and the Society already has chapters in Washington, D.C., Fort Monmouth, N.J., New York, N.Y., Los Angeles, Calif. and Dayton, Ohio. There are several others in formative stages. The chapters hold regular monthly meetings and in addition occasionally sponsor joint meetings and symposia with other societies or with universities. These chapters operate under their own constitutions and independently conduct their own programs and activities.

Individual membership has shown a steady increase until it now numbers 600, including members in foreign countries. Grades of membership include ASSOCIATE, REGULAR, SENIOR, FELLOW and HONORARY MEMBER.

The Society enjoys the support of fifty photographic manufacturers, ranging from the largest to some of the smallest, as sustaining members. Their membership fee provides a substantial contribution to the funds necessary to the publication of the Society Journal. The Journal of the Society of Photographic Engineers, *Photographic Engineering*, is published quarterly and includes papers covering every aspect of the Society's fields of interest from camera design to data reduction, optics and photographic instrumentation to photochemistry and photoprocessing.

A conference is held annually, the subject matter for each having been confined so far to such broad fields as photoprocessing, photographic instrumentation or photographic equipment design. The Third Annual Conference will include a somewhat wider range of subjects. (Since the presentation of this paper, the Third Annual Conference of SPE was held at West Point, N.Y., May 20-22, 1953. The papers presented during the Conference were classified according to the five following groups:

1) Photographic Instrumentation
2) Light Sensitive Systems
3) Chemistry and Physics in the Photographic Process
4) Sensitometry and Processing
5) Miscellaneous

In all, thirty-one papers were presented.)

The Society is making preparations for participation in standardization activities as well as other engineering functions through the work of its committees.

The Society's routine business is conducted by the Managing Secretary whose address is Box 6077, Mid-City Station, Washington, 5, D.C.

* Based on paper presented at the 22nd Annual Meeting, N.Y.C., 1952

BOOK REVIEWS

PRINCIPLES OF COLOR PHOTOGRAPHY, Ralph M. Evans, W. T. Hanson, Jr., and W. Lyle Brewer, John Wiley and Sons, Inc., New York, 709 pages (1953), 6¼ in. x 9¼ in., cloth bound, $11.00.

The title of this book, although entirely proper, may be misleading to the practical worker. It concerns "principles", but in the fundamental, scientific sense, rather than in the applied sense. It forms a generally useful reference source for the more theoretical aspects of color photography, but few photographers will be able to follow more than a small portion of the treatment because of the frequent use of mathematics in developing the subject. It is the type of book that will have lasting value for a limited circle, but limited value for a much wider circle. Nevertheless, the authors are to be congratulated for collecting together in one volume so much pertinent data on the present-day approach to solving fundamental problems in color photography.

INTRODUCTION TO GEOMETRICAL AND PHYSICAL OPTICS, Joseph Morgan, McGraw-Hill Book Co., 330 W. 42nd St., New York 36, N.Y., 450 pages, illustrated (1953), 6 in. x. 9 in., cloth bound, $6.50.

The basic principles are given with both non-calculus and calculus parallel developments. The book is planned as a text to follow a course in general physics and is a readable introduction on an elementary level. Geometrical optics covers the reflection and refraction of light, lenses, mirrors and prisms with brief consideration of the eye, microscope, telescope and spectrometer as instruments. Photometry is briefly covered in a chapter. Physical optics discusses interference, diffraction, resolution, dispersion, polarization and spectra. A final section is devoted to quantum optics. Some basic derivations are given in an appendix and the photopic luminosity function is tabled in a second appendix. Answers are given to the odd-numbered problems and an index completes this useful book. O.W.R.

ADVANCED PHOTOGRAPHY: METHODS AND CONCLUSIONS, Andreas Feininger, Prentice-Hall, Inc., 70 Fifth Ave., New York 11, N.Y., 244 pages, illustrated (1952), 8¾ in. x 11½ in., cloth bound, $7.50.

This is the second book by Mr. Feininger in recent years, the first being "Feininger On Photography", which is acclaimed as the best available book on the technique of taking good pictures. In the present volume the author extends beyond basic principles and gives his reader a more personalized treatment of the subject. Part I of the book, for example, has the general heading "Thoughts About Photography", and the first chapter is entitled "A Philosophy of Photography". His opinions are well-worth reading, even if one cannot always agree with Feininger's views. The author's belief that the camera permits objects and events to be photographed as they appear to the eye is a misconception, but not a particularly damaging one to his philosophical approach.

There are three additional main parts to the book, each of which has a number of chapters. These parts are entitled *Experimentation*, *Observation*, and *Imagination*. The chapters under these headings contain a wealth of useful information to those who are serious about improving their work, especially that improvement which general knowledge and skill can bring about. There are a number of factual errors scattered through the book, but all in all, it is a book to be recommended.

FARBENPHOTOGRAPHIE UND FARBENFILM, Werner Schultze, Springer-Verlag, Berlin, 318 pages, illustrated (1953), 6½ in. x 9½ in., cloth bound. (Available in the U.S.A. from Lange, Maxwell & Springer Inc., 122 E. 55th St., New York, N.Y.)

It is regrettable that this book is not available in the English language. Dr. Schultze presents the subject of color photography on a plane between that of the highly theoretical text and the how-to-do-it manual. The working photographer can gain a much

fuller understanding of the basis of color photography from a book of this type than from any other. Of course, certain aspects of color photography require mathematical treatment, and Dr. Schultze has not been able to circumvent this fact, especially when dealing with the theory of color reproduction. But it is apparent he has been constantly aware that his reading audience would be restricted unless the subject were presented with a minimum of mathematics and other technical methods not familiar to photographers.

Several of the schematic diagrams are in color which add clarity to the presentation. A special tip-in Agfacolor paper print from an Agfacolor negative is included, as well as a card insert with cut-outs containing motion picture frames exemplifying Ansco Color Negative-Positive and Eastman Kodak Color Negative-Positive motion picture materials. There is also a bibliography of 317 references and a complete index.

The book treats all the essential background facts necessary for a sound working knowledge of color photography. A large part of the book is devoted to modern color film and color printing processes, but some of the discussion should have been edited by an American authority before publication. However, it is perhaps excusable that errors and references to unrealiable papers should appear in the author's review of American color film processes, considering that he is a scientist in the Agfa factory at Wolfen, Germany which, being in the Russian zone, puts him out of contact to a large extent with events on this side of the world. Yet, it is amazing how much correct and up-to-date material Dr. Schultze managed to compile on American color products.

THE SCIENCE OF COLOR, Committee on Colorimetry of the Optical Society of America (1932-1952), Thomas Y. Crowell Company, New York, 385 pages, illustrated (1953), 7½ in. x 10 in., cloth bound, $7.50.

This book is the collective effort of 23 leading color authorities who participated on the colorimetry committee of the Optical Society of America. Dr. Lloyd A. Jones of the Eastman Kodak Company was chairman of the committee. Contrary to the high-sounding title, the majority of the book is readily understandable. Except for limited sections, the interested photographer will find no difficulty in coping with it. As a matter of fact, the publishers emphasize its generally non-technical level by stating on the jacket that the book is for "scientists, artists, manufacturers and students".

There are nine main chapters, the titles of which will convey the book's coverage. 1.) From the Art of Coloring to the Science of Color 2.) The Concept of Color 3.) Anatomy and Physiology of Color Vision 4.) Psychological Concepts: Sensory Aspects of Color 5.) Psychological Concepts: Perceptual and Affective Aspects of Color 6.) Physical Concepts: Radiant Energy and Its Measurement 7.) Psychophysics of Color .8) Quantitative Data and Methods for Colorimetry 9.) Colorimeters and Color Standards.

A comprehensive bibliography is included, as well as a combined glossary-index. The subjects discussed are well illustrated by 25 color plates, plus 102 graphs and diagrams.

The book can be highly recommended for the photographer's reference shelf.

THE BRITISH JOURNAL PHOTOGRAPHIC ALMANAC (1953), edited by Arthur J. Dalladay, Henry Greenwood and Co. Ltd., 24 Wellington St., Strand, London, illustrated, 608 pages, 5 in. x 7½ in., cloth bound, 7 shillings 6 pence.

This is the 94th year of publication for the *B. J. Photographic Almanac*. It had its beginnings as a wall calendar in 1859, but for many years it has appeared as a single volume, reviewing the progress in photography for the year previous to publication. In addition, articles of general and technical content, as well as a pictorial section, have been included. The 1953 *Almanac* follows this same pattern, and there seems to be little need for changing it in the future. The volume fully accomplishes its purpose. The articles are quite timely and well done. Mr. Jack H. Coote writes on mechanized photofinishing; Mr. E. F. Linssen on stereoscopic projection; the Editors on photography as a profession, etc. The section entitled "Epitome of Progress" contains much of interest to the technically minded worker, and the section "New Goods" reviews the most recently introduced equipment, particularly that of British manufacture. The usual glossary, formulary, tables and optical data are included.

New Products

NEW B-C FLASH HOLDER

The Kodak B-C Flasholder (sic) which effectively combines the advantages of the Kodak Standard Flasholder, the Lumaclad reflector, and the Kodak B-C flashpack, has been announced by the Eastman Kodak Company. It has a versatile bracket and nonkinking cord that enables it to be used with a great many cameras equipped with a tripod socket screw. Its Lumaclad reflector can be positioned on either side of a camera. Good distribution of reflected light is stated to be one of the major advantages of the reflector. The flasholder is equipped with an extension unit connector post, permitting twin flash synchronization. A 200 mfd condensor is incorporated in the flasholder to give dependable synchronization and long battery life. List price, including the Kodak 2-Way Flashguard, is $10.40.

BACKGROUND MUSIC AND SOUND EFFECTS

Thomas J. Valentino, Inc., 150 W. 46th St., New York 36, N.Y. has issued an expanded list of sound records for motion picture purposes, including background music of all types and many special sound effects. The records are produced by Brull Music, Inc. They are stated to be high fidelity recordings, on 10 inch double-faced shellac discs, 78 R.P.M. Of special interest to those producing educational motion pictures are the recordings of various animal and bird noises and nature sound effects.

LEITZ 4X MAGNIFIER

E. Leitz, Inc., 468 Fourth Avenue, New York 16, N.Y., United States distributors of Leica cameras and accessories and Leitz . .entific instruments, has announced the availability of a new 4x Magnifier with a 45 angle for more convenient viewing when used with the Leitz Mirror Reflex Housing. The magnifier gives an erect image with correct left-to-right orientation. List price from all franchised Leica dealers, $45.00.

HIGH-SPEED 70MM SEQUENCE CAMERA

A new 70mm high-speed sequence camera is being offered by the Charles A. Hulcher Company, Inc., 40 Manteo Ave., Hampton, Virginia. This unique instrument takes pictures on 70mm film at rates up to twenty-five 5 in. frames per second or fifty 2½ in. frames per second. Its mechanical design contains no reciprocating parts and its double disc focal plane shutter provides extremely high motion-arresting characteristics. Its large frame sizes, 7½ or 15 times the area of a standard 35mm camera, greatly facilitates the use of long focal length lenses. The camera is equipped with reflex focusing, variable frame speed control, and electric braking. Frames sizes may be changed in two minutes. The "Hulcher 70" fills the long existing gap between the high-speed small frame of the motion picture camera and the large frame size of still cameras,

producing pictures as large as stills, in sequence as fast as motion pictures. The unit weighs about 32 lbs. and uses standard 70mm perforated film in 100 foot daylight loading spools. It operates on 110 volt AC or DC, and can be made for 28 volt DC power supply. No lens is supplied, but a lens plate for a 7 inch Kodak Aero Ektar f/2.5 lens is provided. Lenses up to 40 in. focal lengths have been adapted to the camera. Various special provisions are available upon request.

NEW ANSCO SERIES 4 FILTERS

Ansco is now supplying Ansco Color Film filters for motion picture cameras using No. 4 size lens attachments. The new filters are available in four different color densities: Conversion #10 and #11, UV-15 and UV-16. Like all other Ansco filters for color photography, these are of the optical glass "sandwich" type, fitted in spun aluminum mounts. The Conversion No. 10 Filter is for adapting daylight type Ansco Color Film to 3200K artificial light. The Conversion No. 11 is for use with tungsten type Ansco Color Film when exposed in daylight. The UV-15 and UV-16 are ultraviolet-absorbing filters, for haze correction in outdoor scenes.

PRECISION RELEASES BOOKLET ON FILM PROCESSING

A new booklet on 16mm and 35mm film processing has been released by Precision Film Laboratories, 21 W. 46th St., New York, N.Y. Printed in color and illustrated, the booklet simulates a personally conducted tour through the Precision plant, which contains many new and expanded facilities. The "tour" takes the reader through each department of the plant, showing exactly what happens to film from the moment it is received through to finishing and shipping.

Copies of the booklet are available free of charge. Requests should be on company letterhead and addressed to Precision Film Laboratories.

OSCILLOGRAPHIC PHOTOGRAPHY

Exakta Camera Company, 46 West 29th St., New York 1, N.Y. announces that a new booklet on Oscillographic Photography is now available. Medical researchers, they point out, use oscillograms to check nerve reactions, the beating of a heart and many other body functions. For further data write the Industrial Publication Division of Exakta Camera Company.

NEW WILLOUGHBYS BOOKLET

A basic booklet entitled "Who Couldn't Be A Photographer!" is being offered, without charge, by Willoughbys Camera Store, 110 W. 32nd St., New York 1, N.Y. This booklet contains useful beginner's information on still cameras, movie cameras and 3-dimensional cameras, color photography, flash photography, and darkroom work. The basic principles of each are discussed and various types of cameras and equipment are explained.

MULTIPLE FILM HANGERS ANNOUNCED BY KODAK

A multiple film hanger that enables photographers to process simultaneously various sizes of professional sheet film, either black-and-white or color, in any processing tank accepting 8 in. x 10 in. film hangers, has been announced by the Eastman Kodak Company. The new hangers take no more space than a single 8 in. x 10 in. hanger. They are available in three sizes. One accommodates four sheets of 3¼ in. x 4¼ in. film, another four sheets of 4 in. x 5 in. film, whereas the third accommodates two sheets of 5 in. x 7 in. film. Films are inserted in perforated channels in the same manner as customary for the standard Kodak 4A Hanger. As many as 48 sheets of 3¼ in. x 4¼ in. or 4 in. x 5 in. film, or 24 sheets of 5 in. x 7 in. film, may be processed simultaneously in an 8 in. x 10 in. size processing tank. Assorted groups of 8 in. x 10 in., 5 in. x 7 in., 4 in. x 5 in., and 3¼ in. x 4¼ in. films may be processed in the same tank.

Kodak Multiple Film Hangers in either the 3¼ in. x 4¼ in. or 4 in. x 5 in. size list at $5.10 each. For 5 in. x 7 in. films, $3.45 each, list.

NEW KODAK BOOKLET ON FILING NEGATIVES AND TRANSPARENCIES

Photographers who must keep their negatives and sheet film transparencies properly filed for ready reference will find a new booklet entitled "Filing Negatives and Transparencies" of interest. A free copy may be obtained from the Kodak Sales Service Division, Eastman Kodak Company, Rochester 4, N.Y.

Your Association

A section of the Journal devoted to official announcements, chapter news, activities of members, and other such matters concerning the Association.

CHAPTER NEWS

Warren Sturgis, Chairman, Chapters Committee

Boston: March 31, Mr. Otto Schaffer of the American Optical Co. spoke on "The Use of the Microscope" after a dinner of Chapter members. April 21, a discussion on "Electronics Flash in Medical Photography" took place at the Dormitzer Electric and Manufacturing Co., led by Mr. Henry Dormitzer. May 19, Mr. Paul Showstark of the Beth Israel Hospital was host at a symposium and demonstration of "Pola Lights in Photography of Surgical Specimens", while Mr. George Ehrenfried of the Polaroid Corp. spoke on "History and Theory of Polarization".

Chicago: June 16, Chapter members toured the new Department of Photography at Mt. Sinai Hospital under the guidance of its Head, Mr. Toni Kuzma. Afterwards several new motion pictures were shown and discussed.

Mid-South: Our newest Chapter is to be congratulated on the zeal and energy with which they are starting. The organization meeting in April was highly successful, and the sixteen members have planned a membership drive throughout their region of the country. Not the least of their accomplishments to date is the issuance of the first number of "The Southerner", a four-page publication of photographic news and members' activities. This endeavour is under the able leadership of Chairman Alex A. Gravesen of the Kennedy V. A. Hospital, Memphis.

New York: May 28, Warren Sturgis spoke on "The Practical Application of Motion Pictures to the Explanation of Medical Problems", and showed several of the latest films produced by his company. Dr. Kenneth Tydings then discussed three-dimension motion pictures in medicine and projected a surgical film made with apparatus which he has developed. Officers for the coming year, elected at this time, will be: Chairman, Jerry Weinstein; Vice-Chairman, Robert Wolf; Secretary, Barbara Turkington; Treasurer, Richard Carter.

Northern Ohio: April 1, Mr. Richard A. Carlson of Carpenter's Visual Service was guest speaker, describing and presenting varied uses of soundstriped film on the new Bell & Howell Projector. Plans for judging the Annual Salon of members, prints were made.

Rochester, N. Y.: April 21, "The Role of Photography in Medical Illustration" and "The Role of Drawing in Medical Illustration" were subjects of papers presented by Dr. Milton G. Bohrod of Rochester General Hospital, and Prof. Natt C. Jacobs of the University of Rochester, respectively. May 19, the Annual Meeting of the Chapter was held, at which several aspects and problems in stereo photography were presented. Those taking part in the symposium were: Roger P. Loveland, H. F. Hoesteroy, and Lawrence R. Reynolds.

Southern California: May 21, Bill Sokol projected color slides as part of his "Talk about Diatoms", and Lee Brown gave a presentation on "Insect Kingdom". June 18, a review of plans for forthcoming Annual Meeting of the B. P. A. in Los Angeles was coupled with a "Motion Picture Night", wherein Cy Wexler showed films and gave pointers on lighting techniques for surgical motion pictures.

Texas: May 23, the Annual Meeting of the chapter was held in Galveston, at which the following officers were elected for the coming year: Chairman, R. A. Kolvoord; Vice-Chairman, Lloyd Willard; Secretary, Bruce Gray; Treasurer, R. M. Christopher.

Upper Midwest: May 16 and 17, a most successful Annual Meeting of the chapter was held in Rochester, Minn., at which were elected: President, Ervin W. Miller; Vice-President, Verlin Yamamoto; Secretary-Treasurer, Lardner A. Coffey. A total of forty members plus their guests attended, including several well-known members of the Chicago Chapter. During the Business Meeting questions of general policy were discussed, in regard to the establishment of a Print Committee and an Annual Exhibit, a trial news-

letter, and the possibility of an annual Chapter Award. The first afternoon was devoted to the following papers: "Techniques in Medical Art (Russell Drake); "Medical Photographs — Exhibition Material" (Verlin Yamamoto); "Endoscopic Photography" (Louis W. Nichols); "George Eastman House — a Slide-Tape Tour" (H. L. Boyer); "Explosive Influences in the Operating Room" (Dr. Albert Faulconer, Jr.). The Annual Banquet was held that evening, of which the feature was "Time-Lapse Studies of Flowers" by Dr. N. W. Barker. On the following morning several special demonstrations were arranged: "Photomicrography" (S. J. McComb); "Gross Specimen Photography" (R. V. Yule); "Photography of Patients" (E. W. Miller).

ACTIVITIES OF MEMBERS

C. George Lefeber and McDonald Smith of the Texas Chapter, and newly joined national members, along with Dr. C. M. Pomerat, won a Silver Medal in the Scientific Section of the recent American Medical Association Convention. Their exhibit illustrated work done in Dr. Pomerat's laboratory in the University of Texas on "Tissue Culture in the Service of Medicine".

Warren Sturgis has been elected Treasurer of the New York Film Council.

C. J. Duncan has sent us a printed Annual Report for 1951-52 of the activities of his group in the Department of Photography of the Medical School, The University of Durham, King's College, England. The report shows beyond doubt that Mr. Duncan and his associates have been extremely active.

David Lubin has left the Cleveland area and is now at the Kingsbridge Veterans Administration Hospital, Bronx, N.Y. The New York Chapter is looking forward to putting him to work.

Arthur I. Bodkins has just been appointed Vice President of the Depix Division of the Polalite Corporation, Whitestone, Long Island. He will be engaged in directing research and development in 3-D motion pictures.

Robert Golden was a co-author of a special report for the U.S. Navy (Report 372) entitled "Depth Dose Measurements of Beta-ray Isotopes with Photographic Film".

Edward F. Bowman, under the supervision of Dr. Monroe A. Rosenbloom, began an extensive research program earlier this year on the use of infrared photography as a diagnostic aid in the detection of breast carcinoma.

We regret that we failed to report that William H. Robinson was awarded over a year ago the U.S. Army's "Award for Superior Accomplishment" in medical photography. This is one of the highest awards a civil service employee may receive from the U.S. Army.

Dr. A. Nichtenhauser had a paper entitled "The Development of the Short Film in Medicine" in the J. Med. Educ., 28:53-61 and 82 (1953). He also collaborated with M. L. Coleman and D. S. Ruhe on a paper that appeared in the N. Y. Health Education Council (1953) entitled "Films in Psychiatry, Psychology and Mental Health".

Jay T. Fox reports that his 16mm film entitled "Birth of a Caterpillar" was judged among the "The Best Ten", and was awarded an NACSA Trophy by the Nippon Amateur Cine Slide Association, Tokyo, Japan. The film was a time-lapse study of a caterpillar emerging from a 2mm egg.

James Fielder Mahaffey is continuing his work on the correlation of photography and photosynthesis. He has also completed a monograph on the skunk cabbage, illustrated by photography.

Dr. E. Rosenthal is now associated with Yale University where, in addition to other duties, he is engaged in research on close-up stereophotography of the eye.

ANNOUNCEMENT

The Association of Medical Illustrators has resumed publication of its official journal under the name of the Journal of the Association of Medical Illustrators, formerly known as Graphics. The issue now in preparation will be available on or before September first. Copies may be procured at a charge of one dollar by notifying the Business Manager, Miss Kathleen Mackay, Woodruff Memorial Building, Emory University, Georgia. The Journal shall be published annually, and shall contain articles, book reviews, exhibit reviews, and other items of interest.

BACHELOR'S DEGREE IN PHOTOGRAPHY

The Rochester Institute of Technology, which has as one of its ten departments, the Department of Photography, headed by C. B. Neblette, has been granted approval to conduct courses leading to the bachelor of science degree. Although details have not been completed it is expected that students entering R.I.T. in the fall of 1953 will be able to continue study toward a bachelorate degree if they so desire. This act became official the last week of June when the New York State Board of Regents gave R.I.T. permission to move ahead with its plan. Students seeking the B.S. degree will carry courses in common with those students working for an Associate in Applied Science degree. The A.A.S. is granted after two or three years' work, but those wanting a bachelorate will be required to take additional courses to qualify for the B.S.

A LETTER TO THE EDITOR

Dear Sir:

I should like to comment on the paper entitled "The Photography of Gross Specimens" by Ella May Shackleford Breckenridge and Béla Halpert.

There are some excellent ideas in this paper which will bear repetition from time to time. However, there are also some ideas which are highly debatable and others which are far from clear. To say that "It is rarely desirable to photograph gross specimens in their fresh unprepared state" is certainly rash, since most doctors much prefer to see specimens in as nearly *in situ* condition as possible. The next statement, "Due to the effect of oxygen on the red blood cells such specimens acquire an unnatural hue" implies that surgeons work in an oxygen-free atmosphere. The paper goes on to list advantages of fixed over fresh specimens. Apparently the authors have in mind specimens containing saccate or hollow organs, tumors, etc., which, when fresh will sag or bulge. This point is not clearly made and might lead the inexperienced photographer to believe that it is impossible always to make a picture of a fresh specimen which shows it in its natural form.

The paragraph on shadows is also very confusing and misleading. It is difficult to understand why eliminating the background shadows "deprives the picture of natural adjuvants of perspective, sharpness and delineation". Since gross specimens are rarely two-dimensional and usually include many curved surfaces, the business about angles and right angles is entirely unacceptable. How does one "penetrate distance" by "an angle approach"?

The authors turn "about face" when they say, "There should be awareness for attractiveness of the environs and for artistic appearance of the specimen". The next sentence stresses again the usual criterion for a good gross specimen picture — that it show what the doctor wants to see "with the least possible distraction". I find it impossible to reconcile the two statements.

Respectfully,

PERCY W. BROOKS,
Department of Photography,
Cornell University Medical College,
New York, N.Y.

PROGRAM

23RD ANNUAL MEETING

AUGUST 31 — SEPTEMBER 3 • 1953

HOTEL STATLER

LOS ANGELES • CALIFORNIA

MONDAY, AUGUST 31

8:30 a.m. REGISTRATION

10:00 a.m. CALL TO ORDER. C. Graham Eddy, FBPA, President: Chief, Medical Illustration Division, Veterans Administration, Washington, D.C.

WELCOME. William L. M. Martinsen, FBPA, General Chairman, 23rd Annual Meeting: Chief, Medical Illustration Laboratory, Veterans Administration Center, Los Angeles, Calif.

THE BASIS FOR CERTIFICATION. Thomas F. Barret, M.D.: Manager, Veterans Administration Research Hospital, Chicago, Ill.

PRESIDENT'S REPORT AND FIRST BUSINESS MEETING.

AFTERNOON SESSION

Meeting at Walt Disney Studios, arriving at 1:15 p.m.

1:30 p.m. LUNCHEON

DEMONSTRATION AND LECTURE ON ANIMATION. Wolfgang von Reithermann, Walt Disney Productions, Burbank, Calif.

FILM — *BEHIND THE SCENES.*
Film shows the Disney Studios, its production facilities and operations.

FILM — *THE LIVING DESERT.*
First full feature length Disney True Life Adventure, scheduled for completion in time for showing at the Annual Meeting.

EVENING SESSION

Hotel Statler

7:30 p.m. SESSION DEVOTED TO PROJECTION OF COLOR SLIDES.

When possible the producers of the slides will be present to discuss the slides and answer questions.

TUESDAY, SEPTEMBER 1

ALL DAY SESSION DEVOTED TO MOTION PICTURE TECHNOLOGY

THE CLINICAL PHOTOGRAPHER'S ROLE IN THE PRODUCTION OF SHORT SHORT MEDICAL FILMS. David S. Ruhe, M.D.: Director, Medical Audio-Visual Institute, Association of American Medical Colleges, Chicago, Ill.

TECHNIQUE FOR EXTREME CLOSE-UPS IN OPHTHALMIC CINEMATOGRAPHY. Robert A. Leonard; Department of Ophthalmology, Medical College of Alabama, University of Alabama, Birmingham, Ala.

The difficulties of photography in ophthalmic surgery will be discussed. By the use of special lens equipment on the Cine Special an area 15mm x 21mm may be photographed from an 18 inch distance, using low wattage lamps. A film demonstrates the results.

EDITING THE MEDICAL MOTION PICTURE. Edward N. Hamilton, FBPA; Director, Department of Visual Education, College of Medical Evangelists, Los Angeles, Calif.

A paper and demonstration. The philosophy of editing will be discussed with its

applications to the medical motion picture. Good splicing is demonstrated. The industry's practice of cutting color originals into A and B rolls is demonstrated. Film illustrates effectiveness.

ANIMATION TECHNIQUES FOR MEDICAL MOTION PICTURES. Spencer Teel: Animation Artist, Churchill-Wexler Productions, Hollywood, Calif.

KAMM-TYPE HOSPITAL STAND AND THE HART MODIFICATION OF THE CINE KODAK SPECIAL CAMERA. Jack Fason: Chief, Medical Illustration Laboratory, Veterans Administration Hospital, Denver, Colo.

The American made, Kamm-Type Hospital Stand will be shown and essential features discussed. The technical features of the greatly revised Cine Special will be presented, concluding with a film produced with the above equipment.

A STAND FOR CAMERA AND CAMERAMAN IN SURGICAL MOVIE WORK. John E. Withee: Director, Department of Medical Illustration, The Hitchcock Foundation, Hanover, N.H.

A ladder-type camera stand, well tried and proven, will be presented as an aid to surgical movie making.

A PANEL OF EXPERTS. Sy Wexler, Moderator, Churchill-Wexler Productions, Hollywood, Calif.

The panel will answer questions from the floor regarding any phase of motion picture technology.

EVENING SESSION

7:30 p.m. SESSION DEVOTED TO PROJECTION OF MOTION PICTURES.

When possible the film producers will be present to discuss the films and answer questions.

WEDNESDAY, SEPTEMBER 2

MORNING SESSION DEVOTED TO PHOTOMICROGRAPHY AND STEREOPHOTOGRAPHY

THE PHOTOMACROGRAPHY OF INSECTS. H. Lou Gibson: Medical Division, Eastman Kodak Co., Rochester, N.Y.

Paper covers the purposes and styles of insect photography, obtaining, subduing, and arranging the specimens and the optical considerations. The latter are similar for all fields of photomacrography and are concerned with making a compromise between the increased depth and the decreased resolution at small aperture.

PHOTOMICROGRAPHY OF DIATOMS. William A. Sokol: Past President, So. Calif. Micro. Soc., Los Angeles, Calif.

Discussion on diatoms. What they are living and fossil types — and how to collect and prepare specimens. Photographic technique (bright field, Rheinberg, dark field, oblique) depends upon structure and size of diatom.

PHOTOMULTIPLIER EXPOSURE DEVICE FOR PHOTOMICROGRAPHY. Frank Crandell: Photo Research Corp., Burbank, Calif.

CORRECT MOUNTING OF STEREOGRAMS FOR PROJECTION. J. L. Simpson: President, EMDE Products, Los Angeles, Calif.

Principles governing correct mounting of stereograms will be discussed and demonstrated.

3-D IN MEDICINE. Pierre LeDoux: Chief, Medical Illustration Laboratory, Veterans Administration, Wood, Wis.

Application to teaching program in physical medicine will be discussed, as well as use with patients as a motivation instrument. Procedure in brain surgery and various fields of medicine will be illustrated.

3-D CINEPHOTOMICROGRAPHY. Zane H. Price: Research Microscopist, Dept. Infectious Diseases, School of Medicine, Univ. of Calif., Los Angeles, Calif.

A study of problems and possibilities involved in taking stereo motion pictures through the binocular mono-objective microscope, including examples of work accomplished.

PROJECTION OF STEREO CLOSE-UP MOVIE, with explanatory remarks and technical data. Ernest Rosenthal, M.D.: Yale University School of Medicine, New Haven, Conn.

AFTERNOON SESSION DEVOTED TO MISCELLANEOUS TOPICS

PREPARING SCIENTIFIC EXHIBITS. Lucille C. Innes: Medical Artist, Visual Education Dept., College of Medical Evangelists, Los Angeles, Calif.

Preferred procedure and a scale model will be presented to demonstrate the points discussed.

HOSPITAL AND MEDICAL PHOTOGRAPHY. Philip D. Bonnet, M.D., Fellow AMA; Administrator, Massachusetts Memorial Hospitals, Boston, Mass.

Paper will include the growing place of visual records in patient care, teaching and research, the importance of good interdepartmental relationships and proper incentives, and ingredients of a successful department.

NEGATIVE-POSITIVE COLOR FILMS TECHNIQUES AND APPLICATIONS IN MEDICAL PHOTOGRAPHIC ILLUSTRATION. Verlin Y. Yamamoto: Medical Illustration Laboratory, Veterans Administration Hospital, Des Moines, Iowa.

Ektacolor negative and print films will be discussed in terms of advantages and limitations, illustrated by slides.

COLOR TRANSPARENCY CHANGES DUE TO VARIABLES. Alex A. Gravesen: Chief, Medical Illustration Laboratory, Veterans Administration Hospital, Memphis, Tenn.

SURGICAL PHOTOGRAPHY WITH THE LEICA. Jack Fason, Chief, Medical Illustration Laboratory, Veterans Administration Hospital, Denver, Colo.

Techniques for surgical photography with the 35mm camera will be shown. Adherence to hospital operating room safety procedures will be emphasized.

A SIMPLE REFLECTOR FOR CAVITY ILLUMINATION. David Lubin, FBPA: Kingsbridge Veterans Administration Hospital, Bronx, N.Y.

Paper describes a simple lighting fixture employing midget flashbulbs. The unit is placed immediately adjacent to the lens providing near axial illumination. Its use simplifies the photography of otherwise difficult subjects.

A TECHNIQUE IN CONTRAST CONTROL OF SENSITIZED MATERIAL. F. C. Breckenridge: Director, Department of Visual Education, Baylor University, College of Medicine, Houston, Tex.

Paper describes a chemical contrast control method.

PHOTO OFFSET PLATE MAKING DEMONSTRATION. Erling Gullixson: Alumo-lith, Los Angeles, Calif.

Rapid method for master multilith reproduction of line, type and halftone copy a diazo process.

EVENING SESSION

7:00 p.m. NATIONAL BROADCASTING COMPANY STUDIOS, Hollywood, Calif. A technical papers session, devoted to problems arising out of the growing alliance between television and medicine.

9:00 p.m. SMOKER.
Informal get-together.

THURSDAY, SEPTEMBER 3

MORNING SESSION DEVOTED TO THE ROLE OF PHOTOGRAPHY IN RESEARCH

PHOTOGRAPHY IN RESEARCH. Oscar W. Richards, Ph.D., FBPA: Research Supervisor for Biology, American Optical Co., Research Center, Southbridge, Mass.

The application of photography for deriving information comes from its sensitivity to radiation, including light. Applications will be discussed to illustrate how photography aids research to gain new and greater knowledge.

A METHOD OF MOTION AND TIME ANALYSIS FOR THE EVALUATION OF PROSTHETIC DEVICES. Marvin S. Gottlieb: Junior Psychologist, Department of Engineering, University of California, Los Angeles, Calif.

INFORMATION FROM ELECTRONMICROGRAPHS. Edward N. Azarowicz: Department of Bacteriology, University of California, Los Angeles, Calif.

Electronmicrography extends beyond photography as a means of recording. It can reveal phenomena and give new information not otherwise obtainable. An example

is electronmicrography of viruses attacking cells of a species of Nocardia. The virus resembles viruses of higher plants and affords a simplified model for the study of the mode of viral attack on a cell.

A METHOD FOR MULTICOLOR RADIOGRAPHY. S. G. Ehrlich, Acme Legal Service, San Francisco, Calif.

Since X-rays of varying intensities penetrate different depths of tissue, three exposures may be made of the immobilized patient in the normal manner. The resultant films are copied photographically and these intermediates are printed on matrix material and dye transfer prints produced. The finished color print is a combined X-ray duplicate with each color corresponding to one X-ray intensity.

HIGH-SPEED MOTION PICTURE INVESTIGATION OF CARDIOLOGICAL PHENOMENA. Dale GILLETTE and Eleanor Gerlach, Cedars of Lebanon Hospital, Los Angeles, Calif.

Investigation involves the use of high-speed color motion pictures, high-speed oscilloscope, and the electrocardiograph.

SECOND BUSINESS MEETING.

AFTERNOON SESSION DEVOTED TO SPEED FLASH TECHNOLOGY

PRACTICAL METHODS OF APPLYING AND USING SPEEDLIGHT. Harry L. Parker; American Speedlight Corp., New York, N.Y.

Discussion will cover speedlight design, equipment standardization, and methods applicable to the use of speedlights in medical and biological photography.

FLASH TUBES. F. E. Carlson; Engineering Dept., General Electric Co., Nela Park, Cleveland, Ohio.

Discussion will cover types, tube efficiencies, reflector design.

VERSATILE ELECTRONIC-FLASH POWER UNIT. Frank Crandell; California Institute of Technology, Pasadena, Calif.

A PHOTO TRUCK FOR CLOSE-UP PHOTOGRAPHY. Lloyd Matlovsky; Chief Photographer, Los Angeles County Hospital, Los Angeles, Calif.

A light truck mounting electronic speedflash unit and camera stand will be described. Field finding and focusing is accomplished by projecting an image of a reticle upon area to be photographed.

EVENING SESSION

6:30 p.m. COCKTAIL PARTY.
The Eastman Kodak Company is our host.

7:30 p.m. ANNUAL AWARD BANQUET.

Prominent speaker and toastmaster. Informal dress.

SALON: Prints and transparencies will be hung in the exhibition room housing the Commercial Exhibits. Several special exhibits will be displayed, including an exhibit from the V. A. devoted to *The History of Medical Illustration;* another from the U.S. Naval Medical School and possibly one from the Royal Photographic Society's Centenary of Medical Photography.

COMMERCIAL EXHIBITORS: American Speedlight Corporation; Ansco; Atkinson Laboratories; Bausch & Lomb Optical Company; Berndt-Bach (Aurecon); Lester Dine; E. I. du Pont de Nemours and Company; Eastman Kodak Company; EMDE Products; Erb & Gray; Oscar Fisher; Kling Photo; Mitchell Camera Corporation; J. G. Saltzman, Inc.; Silge & Kuhne. We anticipate other exhibitors in addition to above.

OTHER ACTIVITIES: For Friday, September 4, a trip is planned to Corriganville, Calif. This is a Movie Ranch, the location of many fabulous movie spectacles and most Western style movies. In addition to seeing the streets, villages and forts of this 2000 acre Movie Ranch, and meeting "Crash" Corrigan in person, there will be a Western style barbeque, complete with Chuck Wagon and Western music.

LADIES' PROGRAM: A complete program including visits to world famous Farmer's Market will occupy the ladies not attending the technical sessions.

REGISTRATION: If you have not already registered, AIR MAIL or TELEGRAPH your registration NOW!

OFFICIAL PHOTOGRAPHER: Pierre LeDoux.

NEW B.P.A. MEMBERS

(April through June, 1953)

Francis W. Abney, *Woodland Hills, Calif.*
Robert H. Barter, M.D., *Washington 16, D.C.*
William C. Beck, Jr., *Fort Howard, Md.*
Harold C. Belyea, *Syracuse, N.Y.*
Robert C. Benassi, *N. Augusta, S.C.*
Harold L. Boyer, M.D., *Las Vegas, Nev.*
Martha Brunings, *Rochester, N.Y.*
Richard A. Buckingham, M.D., *Oak Park, Ill.*
Valentine J. Connolly, *Staten Island 4, N.Y.*
M/Sgt. Edgar A. Covert, *Denver, Colo.*
Dr. Thieran A. Cromartie, *Tuskegee, Ala.*
John D. Danchertsen, *Houston, Tex.*
Joseph R. Dant, *Dublin, Ga.*
Donald B. Douglas, Jr., M.D., *New York, N.Y.*
Edward Entin, *Bronx, N.Y.*
Sidney Falkowitz, *Forest Hills, N.Y.*
Jack Fletcher, *Memphis, Tenn.*
Ed Friend, *Atlanta, Ga.*
Leonard Fulton, *Camden, N.J.*
Walter Eugene Furr, Jr., M.D., *Cleveland, Ohio*
Anthony A. Gavey, M.D., *Springfield, Ohio*
William I. Glass, M.D., *Bridgeport 4, Conn.*
Aureo F. Gutierrez, M.D., *Manila, Philippines*
A. Fletcher Hall, M.D., *Santa Monica, Calif.*
Eloise R. Hammes, *Birdsboro, Pa.*
K. L. Hartenbower, *Kingston, Wash.*
Charles P. Haseltine, M.D., *Oshkosh, Wis.*
Dr. Lowell V. Heisey, *Bridgewater, Va.*
Alfred R. Henderson, M.D., *Wanamassa, N.J.*
Sou Jie Ho, M.D., *Rochester, N.Y.*
Barbara Jacobs, *Brookline, Mass.*
Frances R. Johnson, *Madison, Wis.*
James A. Johnson, *Rochester, N.Y.*
Harlan B. Kelley, Jr., *Denver, Colo.*
Joseph P. Kelly, *New Rochelle, N.Y.*
Dr. Abel Lajtha, *New York, N.Y.*
Frank Lavernia, M.D., *Havana, Cuba*
C. George Lefer, *Galveston, Tex.*
David G. Lilly, *Morgantown, W.Va.*
Ray Lookofsky, *Bronx, N.Y.*
David Lurie, *Rochester, N.Y.*
Kenneth Scott McCarty, *Forest Hills, N.Y.*
R. M. Moose, M.D., *San Bernardino, Calif.*
Harold E. Morgan, M.D., *Newton, Kan.*
Robert William Myers, M.D., *Newton, Kan.*
Chester C. Neese, *Fergus Falls, Minn.*
Jack Parlow, *York Mills, Ont., Canada*
Gus J. Piros, *St. Louis, Mo.*
Rosebud Lane Preddy, *Bellflower, Calif.*
Robert C. Ranquist, M.D., *Chicago, Ill.*
Irving M. Richman, M.D., *Beaumont, Tex.*
James E. Roberts, M.D., *Los Angeles, Calif.*
James Travis Robinson, Jr., M.D., *Kansas City, Mo*
Saul Rosenberg, M.D., *Bridgeport, Conn.*
Jean Rossano, *Quebec, Province of Quebec, Canada*
Dr. Peter S. Roy, *Jacksonville, Fla.*
Herbert Sacher, *Far Rockaway, N.Y.*
Carmelita Salazar, *Lakewood, Calif.*
Anthony E. Salerno, *Corona, N.Y.*
Felix P. Schillesci, Jr., *New Orleans, La.*
Harold Schwartz, M.D., *Cleveland Heights, Ohio*
Leon Schwartz, *Rochester, N.Y.*
William L. Secor, *Syracuse, N.Y.*
Hyman Shaffer, *Newton, Mass.*
Gershon Shapira, *Jerusalem, Israel*
McDonald Smith, *Galveston, Tex.*
Merian B. Smith, *Madison, Wis.*
Melvin Spira, *Augusta, Ga.*
Howard L. Stitt, M.D., *Cincinnati, Ohio*
Robert Stolar, M.D., *Washington, D.C.*
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Superior craftsmanship in still or motion picture photography of biological subjects. Ability in photographic research in new methods or materials.

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Meritorious contributions to biological photography overall through sustained organizational work.

Two sponsors are required. The sponsors should be well acquainted with the candidate's work and should be ready to furnish the Board with details of his experience and achievements. Those who wish to sponsor a member whom they believe to be eligible should request a Fellowship Application form from the Secretary of the Fellowship Committee: Miss Anne Shiras, Photographic Department, Magee Hospital, Pittsburgh 13, Pennsylvania.

CONTENTS

JOURNAL OF THE BIOLOGICAL PHOTOGRAPHIC ASSOCIATION

Volume 21, Number 3 — August, 1953

STORAGE OF NITRATE AMATEUR STILL-CAMERA FILM NEGATIVES . . . . . J. M. Calhoun 1

INFRARED PHOTOMICROGRAPHY WITH THE ELECTRON IMAGE CONVERTER TUBE . . . . . Charles Maresh 14

A TIME-LAPSE CINEPHOTOMICROGRAPHIC APPARATUS . . . . Lewis W. Koster 24

MEDICAL ILLUSTRATION AND PSYCHIATRY . William H. Campbell 28

CINEMATOGRAPHY OF THE HUMAN EARDRUM . . H. G. Kobrak 35

STEREOSCOPIC PHOTOGRAPHY OF BIOLOGICAL SPECIMENS WITH AN ORDINARY CAMERA . . . . Valentine J. Connolly 39

PHOTOGRAPHY IN MEDICINE AND SURGERY . . . Frank Smith 42

THE SOCIETY OF PHOTOGRAPHIC ENGINEERS . Edward K. Kaprelian 43

BOOK REVIEWS . . . . . All reviews by the Editor except that noted by Oscar W. Richards 44

NEW PRODUCTS 46

YOUR ASSOCIATION . . . . . Chapter News, Activities of Members, Announcements, Letter to the Editor, Program for the 23rd Annual Meeting, and New B.P.A. Members 48

CONTRIBUTING MEMBERS 56

SUSTAINING MEMBERS, FELLOWS OF THE ASSOCIATION, FELLOWSHIP PROCEDURE . . . . . Inside Back Cover

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